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TRAYLOR
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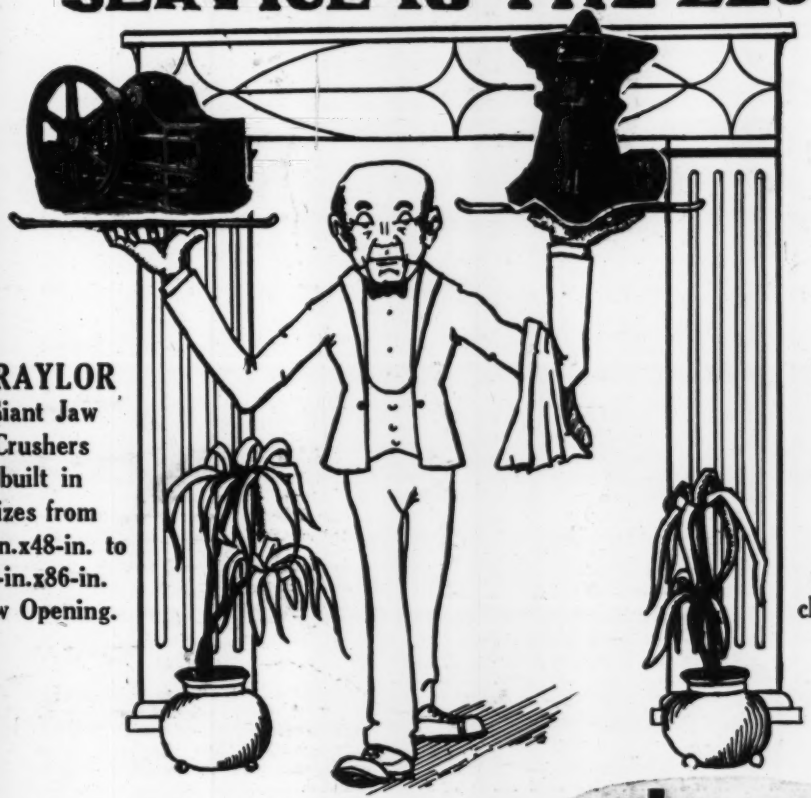

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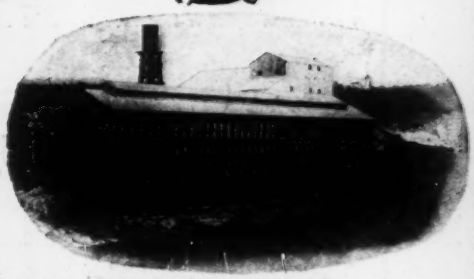

The 3,000-ton Crushing Plant of the H. S. Kerbaugh, Inc., at Valhalla, New York, equipped throughout with TRAYLOR CRUSHING AND SCREENING MACHINERY.

The Unwatered Cofferdam Of Lackawanna Steel Sheet Piling, For Building Lock No. 2, Cape Fear River, Brown's Landing, N. C.

The view shows a number of interesting features, particularly the concrete floor (5 feet thick) which was poured under water for watertightness. At low stages, the leakage runs from 200 to 500 gallons per minute, which considering the enormous size of the cofferdam, is very small and requires comparatively little expense for pumping.

The splices which were put in to permit leaving the lower part of the inner steel wall as a permanent protection are prominently shown at the lower left corner. Over 17 per cent of the Lackawanna Sheeting is to be kept in position for this purpose.

This cofferdam has withstood a head of 30 feet since pumping out the first time, and has been flooded *five times in one season* by river freshets. The river has flowed over the top of the dam even to the extent of carrying out the tremie barge shown resting on the floor, yet no damage to the cofferdam has resulted.

Such performance certainly evidences the good judgment of Government Engineers in using steel sheeting of the Lackawanna type exclusively in this job, the similar lock at Kings Bluff, 33 miles farther down the river, and for the great Black Rock Ship Lock at Buffalo, N. Y., the largest construction of its kind on record.

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271

Engineering News

VOLUME 76 DECEMBER 21, 1916 NUMBER 25

New Multiple-Arch Dams in the Sierra Nevadas

In the upper levels of the Sierra Nevada Range numerous depressions in the granite formation act as storage areas for a portion of the runoff from the adjacent watersheds. Many of the small natural lakes thus formed occupy reservoir sites admirably adapted to economical development for hydro-electric enterprises. Gem Lake and Agnew Lake, two adjoining basins of this character, located in Mono County, California, have been developed this year by the Pacific Power Corporation as an additional unit in the system that supplies current to the larger southern California cities, Imperial Valley and many of the Nevada mining camps.

With a tributary area of 22 sq.mi., yielding an annual runoff of approximately 2 sec.-ft. per sq.mi., Gem Lake has been converted into a reservoir of 17,000 acre-feet capacity, with a surface elevation of 9,050 ft., by the construction of a multiple-arch dam of the Jorgensen type. Agnew Lake, below and immediately adjoining Gem reservoir, with an additional watershed area of 1.65 sq.mi., will be enlarged to a capacity of 400 acre-feet by the construction of a smaller multiple-arch dam of similar design.

Gem Lake dam is approximately 700 ft. along the crest, has 16 arches, each with a 40-ft. span, and a fractional arch at each end. Its highest arch is 112 ft. above the foundation and 84 ft. above ground surface. The maximum thickness of concrete at the base of the arch is 3.6 ft., and at the crest is 1 ft. Buttresses are 5 ft. long in plan on top and tapered. In the buttresses the mix is approximately 1 : 2½ : 5 and in the arches 1 : 2 : 4. A total of 8,500 cu.yd. of concrete was used in this structure, and 90 tons of reinforcing steel.

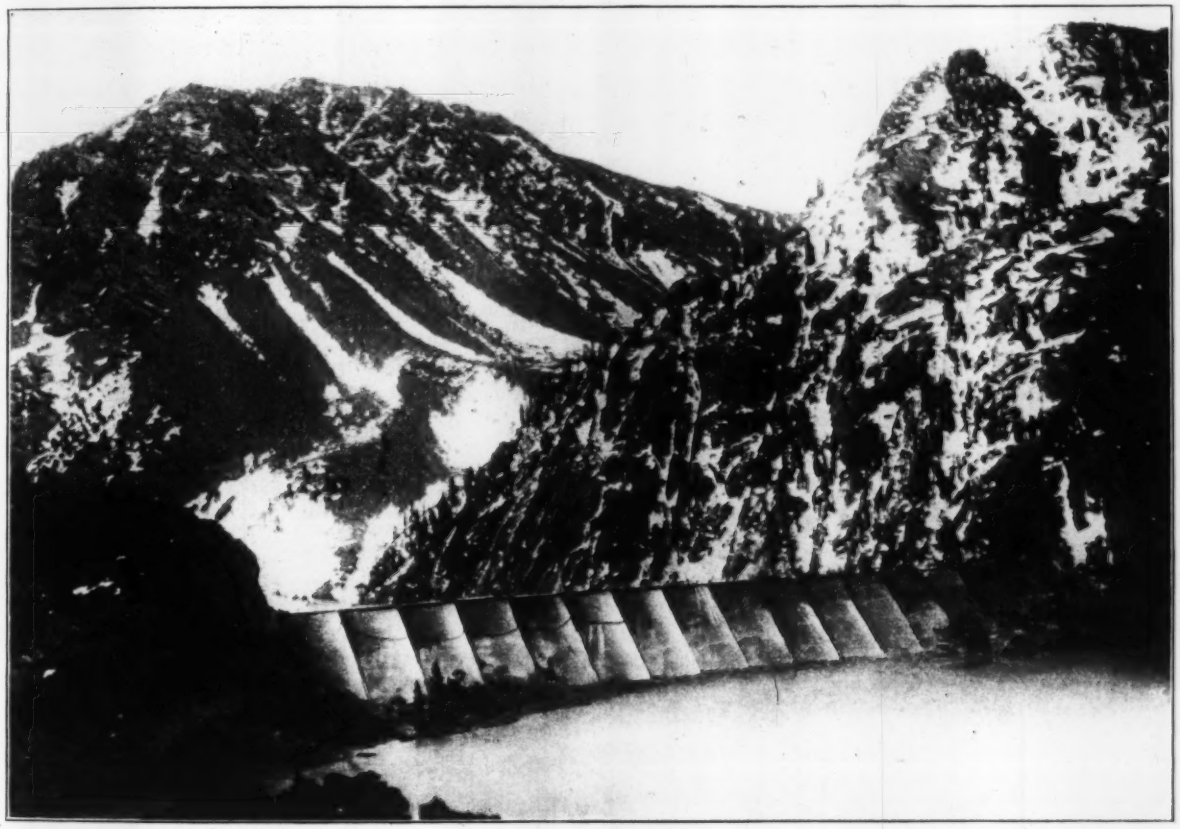


FIG. 1. THE COMPLETED GEM LAKE DAM IN THE SIERRA NEVADA MOUNTAINS

Reinforcing bars are spaced as shown in Fig. 2. Their function is to withstand contraction stresses due to excessive cold, which will produce tension at the center of the

intrados and near the buttresses on the extrados surface. The arches are cylindrical on a portion of the upstream face, but from El. 15 to the crest, unlike the Eastwood multiple arch, they are elliptical, to keep the center line of pressure and the center line of the arch as near coinciding as possible. The deviation of the two is due to the fact that the water pressure at the crown on any arch slice is 7 ft. less than at the corresponding point at the abutments; and the effect of this has to be compensated for in logical manner, which is accomplished by the elliptical section.

On Gem Lake dam, as well as on the smaller structure at the lower dam site, the crest of the eight spillway openings per arch is 3 ft. below the true crest elevation. These openings will discharge 100 cu.ft. per sec. of water each. Two arches on each dam are provided with these openings.

Agnew Lake dam is nearly 280 ft. along the crest, has seven arches and a maximum height of 30 ft. The arches are 2 ft. in thickness at the base and 1 ft. at the crest, the total volume being 664 cu.yd. The surface of the reservoir that it will impound will be about 550 ft. below the surface of Gem Lake reservoir. Its function will be to furnish an auxiliary supply for peak loads at the power house, which will be located at Silver Lake, 1 mi. east of Agnew Lake, at an elevation of 7,212 ft. above sea level.

Water is taken from Gem reservoir through a 48-in. steel pipe, which is concreted in an outlet tunnel about 300 ft. in length, whose intake is 20 ft. below the natural level of the lake. Below Agnew Lake this pipe branches into two 30-in. pipes, reduced in diameter at the power house to 26 in. Both pipes can be supplied from either reservoir. In the tunnel the pipe is of $\frac{3}{16}$-in. riveted steel. Below the Agnew dam, lap-welded steel pipe of American manufacture is used, varying in thickness from $\frac{1}{4}$ in. to $\frac{7}{8}$ in., according to head. A series of tests of the strength of the weld was made to determine the strength of the joint, since before the war much of this type was imported from Germany, and some doubts existed as to the efficiency of the American product. The strength of the joint, as shown by these tests, varied from 96% to 105% of the strength of the unwelded metal.

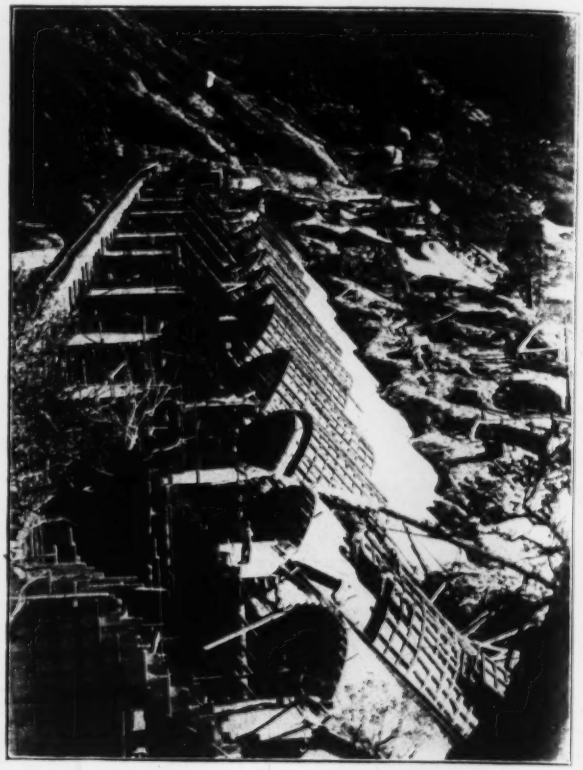


FIG. 3. GEM LAKE DAM UNDER CONSTRUCTION

Pipes lead direct from the reservoirs to two Pelton-Doble 5,000-kw. units in the power house, of which one is now in operation. These will give a total production

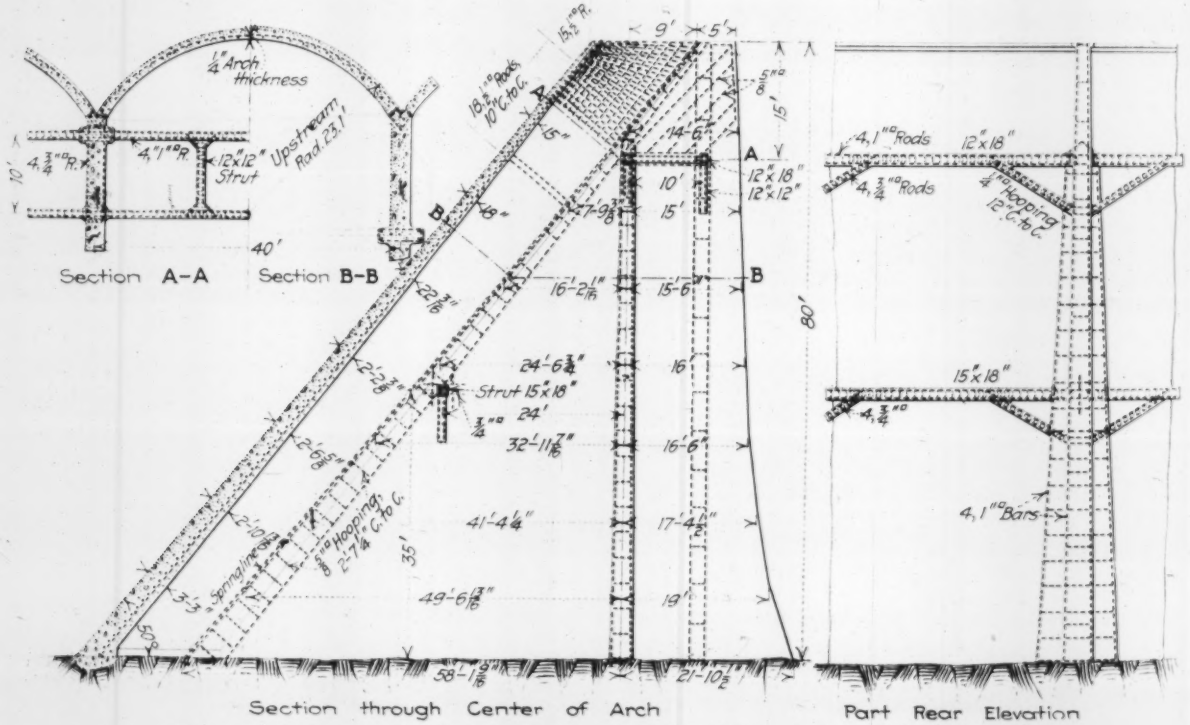


FIG. 2. DETAILS OF THE REINFORCED-CONCRETE MULTIPLE-ARCH GEM LAKE DAM

of 13,400 hp. from the station, which will operate under a static head of slightly over 1,800 ft. from Gem Lake and 1,250 ft. from Agnew Lake. Current will be transmitted at 60,000 volts for the present. Later it will be stepped up to 140,000 volts.

Material Hauled Far to the Site

Cement for the work was hauled 60 mi. by six 75-hp. gasoline caterpillar tractors, from Benton, a station on the Southern Pacific, in Mono County. The tractors were unloaded at the upper end on Silver Lake and their contents brought to Agnew Lake on a tramway, then ferried across on barges and then loaded on another tramway that terminates at the mixer house. The total cost of transportation from the railroad to the upper dam site was so high that the cement on the job cost $7.50 per bbl.

FIG. 4. WATERPROOFING THE UPSTREAM FACE OF GEM LAKE DAM WITH CEMENT GUN

Rock was obtained from the tunnel dump and from an adjacent slide. It was crushed and segregated into three sizes by means of revolving screens. All screenings below ¼ in. in size were classified as sand—about 25% of the total amount required being obtained from this source. The remainder was excavated from the lake shore.

The largest-size rock used in the concrete was 2 in., and very few pudding stones were deposited in the aggregate when it was in place. One ½-yd. concrete mixer discharged into buggies in which the concrete was conveyed to the forms.

Timber for forms, camp buildings and tramways was cut by a sawmill near the dam site. In all, 930,000 ft. b.m. was required. Work was finished on Nov. 18 of this year, except for some plastering of the upstream face, which is being done by means of a cement gun (Fig. 4).

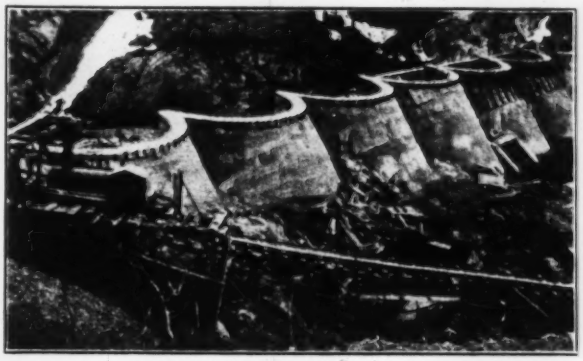


FIG. 5. THE NEARLY COMPLETED AGNEW LAKE DAM JUST BELOW GEM LAKE

L. Jorgensen was the designer and Supervising Engineer of the dams, and C. O. Poole was Chief Engineer of the entire development. E. J. Waugh was Resident Engineer; L. B. Curtis, Field Engineer; and R. S. Manifold, Civil Engineer; F. O. Dobson, Superintendent of Construction. The contract was performed by the Duncanson-Harrelson Co., of San Francisco.

Speedy Precise Leveling

In *Engineering News*, Nov. 30, 1916, p. 1011, there was published a brief note on the record progress made by John H. Peters, in charge of a precise-leveling party of the United States Coast and Geodetic Survey working in Michigan. Mr. Peter's party, for instance, ran a double line over a distance of 159.6 mi. in the month of September, 1916.

How this kind of work impresses the uninitiated engineer is well set forth in the following extract from *The Holcad*, the publication of Michigan Agricultural College:

> Watching the Geodetic Survey men run levels along the Michigan Central tracks from Holt to Lansing was an interesting sight. There was a time when these men walked, as the common or garden variety of surveyor does; now, however, the Government men are considerably more efficient and speedy. The level they use is mounted on a gasoline "go-devil" which one-lungs its way along a railroad track at about 15 mi. an hour, and a second gas car has mounted on it an adding machine for the use of the recorder. The rods are graduated to the metric system and the readings are taken by the very accurate three-reading system. Some idea of the speed with which these Geodetic Survey men work may be had when the fact is known that they ran a mile of levels in a few minutes less than half an hour.
>
> If some of the underclassmen had witnessed the interesting episodes that happened along the Michigan Central tracks, the title "dignified senior" would soon be as extinct as the dodo. The senior civils and a few juniors, headed by Professor Cade, met the geodetic men about two miles this side of Holt and undertook to watch them work. Vain hopes! The only glimpses of the work the seniors had, after the first greetings were over, were few and fleeting. The gas car started up the track to a new set-up while the senfors started to walk leisurely beside it. Soon that walk developed into a trot; then into a dead run. In a few short moments a bunch of about 40 men were strung out behind that gas car like a comet's tail, each and every man throwing cinders 30 ft. in the air in a desperate endeavor to keep within seeing distance of the survey party. Then just as the first panting, gasping senior arrived at the scene of action, the level men would leave rapidly and with much noise for a point a few hundred yards farther up the track, leaving the seniors to repeat the performance. After a mile or so of marathon work most of the class came to the conclusion that there was too much speed in that job for them, and so they left for the street-car line, a mile to the east.

Rectangular Wooden Flumes

By J. C. Stevens*

The object of this article is to touch briefly on a few important points connected with the design and construction of wooden flumes for irrigation and power purposes, that have not been treated either in textbooks or in technical articles, so far as the author is aware.

The author will preface his remarks with this advice: Do not build wooden flumes for permanent institutions if funds are available for more lasting types of construction. He hastens to add that where circumstances demand, good wooden flumes can be built that under careful management will last in serviceable condition for many years.

The life of wooden flume under Western irrigation practice may be taken as 10 yr., while that of steel flume with wooden substructure on masonry footings may be taken as 20 yr. It is easy to figure that it will be cheaper to construct and maintain two sets of wooden flume, during a 20-yr. period, than one of steel. Nevertheless the sense of security felt by the management and the confidence it will inspire in prospective settlers under a system where steel flumes are in use will more than offset the difference in cost.

In the majority of cases, however, the funds available for a proposed development make it necessary to construct wooden flumes or none at all. Under such circumstances a type of flume must be adopted that is simple and cheap, and that can be maintained and repaired at minimum cost.

Choice of Lumber—Seasoned vs. Green

For the flume box, redwood will probably give the best results, but it is expensive and often out of the question. In the Northwest the next best cheap material is Western yellow pine. Douglas fir will probably outlast the yellow pine, but it checks so badly that it is very difficult to keep fir flumes tight, especially under the intermittent use for irrigation. Douglas fir is probably the best material for the substructure, although yellow pine, spruce and hemlock are extensively used.

The condition of lumber as to seasoning is a very important feature, and on it largely depends the type of joint to be used. For tongue-and-groove joints, spline joints, or shiplap it is very important to use well-seasoned lumber placed dry. Even well-seasoned lumber placed in damp weather will afterward shrink enough to open any of these joints. Subsequent warping will prevent complete closure when water is next turned in, and permanent leaks will develop.

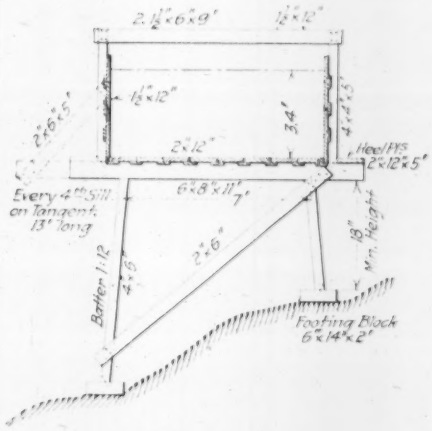
Many flumes have been built of green lumber, fresh from the saw and often floated to the point of use after milling. Such practice, especially for irrigation flumes, cannot be too strongly condemned. Where this method is used, however, a simple butt joint with battens on the outside should be adopted, and under no circumstances a tongue-and-groove, spline or shiplap joint.

The drier the lumber used the tighter will be the flume, hence it is important always to use well-seasoned lumber laid in dry weather. If possible, lumber should be air-seasoned in the rough for at least a year in properly stuck piles or kiln dried. Just before construction the flume plank should be milled to dimensions. If this is done the plank will be found to have nearly uniform dimensions, the construction will be greatly facilitated, and a much tighter and better flume will be obtained. No buckling of plank from subsequent saturation will result if they are properly nailed in place.

A year's air seasoning is often out of the question, however, and in such cases as long a time as possible should be given. Even the drying received in as short a time as two weeks in well stuck piles will be well worth the extra cost of piling.

Milled vs. Rough Lumber

The substructure and especially the battens are best made of rough lumber. The flume box is generally made of milled lumber for two reasons: One side of the planks are often dressed and placed with the planed surface inside to reduce friction; planks are often sized



TYPICAL WESTERN IRRIGATION FLUME

Bents 4 ft. c. to c. Battens to be 1x6 in., cut long, sprung in between posts and sills, and nailed with 10d nails 6 in. c. to c., staggered and clinched.

one side and one edge or sized one side and two edges to secure uniformity of dimensions.

Experiments on the flow of water in flumes show, for the stretches selected, a slightly lower coefficient for dressed than for rough lumber. In practice, however, the capacity is often governed by the amount of dirt or gravel in the bottom of the flume, or by a slimy growth that will attach itself to either planed or rough lumber. As far as carrying capacity is concerned there is not a great deal to be gained by planing the flume plank.

There is no doubt but that a far better flume can be built of uniformly sized planks. On the other hand the rough edges of planks will hold silt better than planed edges and thus will produce tighter flumes.

It is practically useless to size flume lumber when it is green, because, in drying, the shrinkage is not uniform and considerable variations will be found in width of planks after they have had a few weeks of air drying. Sizing of lumber also reduces its strength as well as dimensions for which due allowances must be made in the design.

If lumber is well seasoned, the best practice is to use plank sized one side and one edge to facilitate construction and to insure tight joints. In laying place a rough edge and a smooth edge together. An alternative plan, if there is a saving in cost, would be to use plank sized

*Consulting Hydraulic Engineer, Spalding Building, Portland, Ore.

one edge only, since it is desirable to secure plank of uniform width if possible.

If the lumber is green, use the flume planks in the rough—that is, without sizing. In constructing do not break joints but build the flume in 16-ft. lengths. Then trim the wide end of the last panel (usually 4 ft.) of the bottom to meet the width of the narrow one at the joint. Sides need not be trimmed. A variation of an inch or so in the width of the flume will thus result, but it is not a serious matter.

The most practicable longitudinal joint for flume plank, considering cost, ease of repair, calking and rapidity of closure, is a simple butt joint with a batten on the outside. Battens should never be placed on the inside of a flume. It is a waste of lumber, for they serve no useful purpose in this position. Unless they are placed on the outside it is better to omit them altogether. This applies equally to the flume proper and to the transition section that is buried in the earth.

Typical Western Irrigation Flume

The accompanying illustration shows the type of flume that has been gradually evolved in Western irrigation practice. It has no bolts, no mortise joints, no dapping. Nearly all sticks can be cut to size at the mill, thus reducing field carpentry to a minimum.

Flume planks should be drawn to as close a fit as possible at all longitudinal joints. Battens are cut to fit snugly between side posts and sills and are driven into place. They should be securely nailed to the planks and the nails clinched on the inside of the flume. Both flume planks and battens should be of well-seasoned yellow pine, white pine, sugar pine, cedar or redwood. Fir is not desirable, but all other timbers may be of fir.

If there is sufficient money available, footings should be of masonry built high enough to keep the ends of the posts above the soil. This, however, is quite expensive, and the use of wooden footing blocks is quite general in the West. The life of the flume will be materially lengthened if footing blocks are of timber treated with creosote or other preservative. The bearing surface on soils must be for that soil in a saturated condition, and generally should not exceed one ton per square foot. Posts should be cut to exact length, and the use of shims should never be allowed.

Bench flumes on steep side hill should always be avoided, as soil will collect against the flume box on the upper side and cause early decay. A much better plan is to set the flume on posts free from the hillside, burying the footing blocks and post in the soil and backfilling so as not to disturb the original slope of the material.

Importance of Extension Joints

If flumes are built of seasoned lumber, it is very important to provide extension joints. If this is not done, subsequent saturation will lengthen the flume enough to lift it clear of its supports on the inside of curves. On sharp bends around rocky points the flume may even be pushed off its footings altogether. This is particularly true of the smaller sizes. The author observed a flume 2 ft. in width without extension joints wrecked at a sharp curve when water was first turned into it. The extension was sufficient to tip the flume so that water poured over the side on the outside of the curve and washed out the footings.

Experiments by D. C. Henny on kiln-dried lumber measured before and after saturation in tanks shows the following percentages of extension:

	Range	Average
Sinker redwood	0.01 to 0.05	0.037
Soft redwood	0.02 to 0.18	0.143
Hard redwood	0.08 to 0.24	
Sap redwood		0.097
Yellow fir		0.117
Red fir		0.053

Experiments by the author on yellow pine air-seasoned for 6 months, measured before and after saturation, gave the following average percentages of extension: Yellow pine (*Pinus ponderosa*) series 1, 0.064; series 2, 0.054.

On constructed flumes some of this extension is taken up by crushing at the joints so that the extension to be provided for is somewhat less than that shown above. On a flume constructed of yellow pine air-seasoned for 60 days an extension of $3\frac{3}{4}$ in. in 735 ft., or 0.013%, was observed following a few days of rainy weather. The flume was practically on tangent with one end free.

A questionable practice has been to leave about ½ in. space between ends of planks at panel points. If the flume is empty, and extension results from wet weather, the nails will give but little and the flume will be lifted at critical points. Moreover, to take up the extension the nails must bend, and this induces leakage. If the flume has battens on the outside, the joint is useless since the battens will prevent the extension being taken up in this manner.

The location of extension joints is largely a matter of judgment and experience, as they must be placed with reference to the alignment of the flume and height of posts.

Perhaps the best type of extension joint is a V-joint of galvanized-iron sheets joining two collars spaced about 1 in. apart. This forms a sort of bellows between adjacent panels and can be made practically water-tight. Another type can be made entirely of wood by ending one panel on a false collar that slides on a larger collar fastened to the other panel.

Where green lumber is used extension joints are not so imperative, particularly on large flumes. During construction, however, an occasional open panel should be left at curve points until just prior to the time of filling. This will prevent the footings being lifted due to extension from rains or snow until the flume receives its load. Under its load much of the extension will be taken up by tightening and crushing at the joints. The subsequent drying in the nonirrigating season may pull the joints slightly, but it is not likely to lift the footings.

In the design overturning can rarely be provided for by the batter of the posts. For example, a 5x3-ft. flume on 16-ft. posts will require a batter of 2.6 in 12, and on a 34-ft. trestle posts with a batter of 3.75 in 12 will be required to resist a wind pressure of only 15 lb. per sq.ft. on exposed surfaces with flume empty. For a 2x2-ft. flume the required battter is 7.8 in 12 for 16-ft. posts.

Such batters are of course impracticable and some other means of resisting wind loads must be provided. The simplest plan is to build all flumes with the same batter to the posts, say 1 or 1½ in 12, then provide guys at critical points. Only the exposed portion of flumes need be anchored in this manner.

The author has successfully used 3/8-in. galvanized-iron messenger cable anchored to creosoted dead timbers buried in the ground. A constant batter of 3 to 5 was given the cables, but the spacing of anchors was varied from 32 to 96 ft. or greater, depending on the size of flume, height of posts and exposure to winds.

The wind pressure above cited—15 lb. per sq.ft. of exposed surfaces—is about half that usually adopted for bridge and building designs, but if flumes are built to withstand a wind load of 15 lb. per sq.ft. they are amply safe.

Importance of Careful Priming Before Use

By this term is meant the first filling with water. If there is a point of weakness anywhere in the flume, the water will soon discover it. The secret of successful operation is to detect incipient trouble and make repairs before damage occurs.

On most soils the leakage that inevitably occurs between the time water is first turned in and the joints have closed by swelling of the flume plank cannot be permitted. On rocky foundations, where leakage can do no property damage or endanger the footings, the flumes may be allowed to close of themselves.

The only sure method of preventing this leakage is to calk all side joints with oakum prior to turning in the water. During construction it is best to leave a 1/8-in. calking space between butt joints of the side plank. The most important joint to be closed is the butt joint of the bottom side plank. Oakum should be forced below the top of the bottom plank, onto the sill in this joint, or leakage will occur here ever afterward and cause early decay of the supporting timbers. The joints of the bottom will rarely give trouble and are quickly closed.

A simple effective method of priming is as follows: Throw in a wheelbarrow of fine soil about every 20 ft. for a large flume. At the upper end of the flume throw in a wagon load of sawdust. The first water turned in should not be over 3 or 4 in. deep in the flume, and as it advances workmen with rubber boots and shovels should stir the silt and sawdust into the water. Almost instantaneous closure of the bottom joints will result. If any of the butt joints of the bottom side plank have not been calked it will be evident at once, and they must be calked before the water is raised.

Water should then be raised slowly, about 2 in. per day or less, until the required depth is secured. Oftentimes the water is held for a day or more at the height of one of the side joints or just over it until closure by swelling and calking is secured. If settlement occurs, the flume should be immediately raised to grade and the footings enlarged or other means adopted to prevent a recurrence. Oftentimes leakage water can be led away from footings on treacherous soil by means of wooden V-troughs, or canvas sheets may be spread over the soil to collect the water, from which it is readily conducted by ditching.

After the flumes have become thoroughly soaked they will become practically water-tight. The author has seen stretches of a mile or more of this type of flume carrying a good head of water, but with hardly a drop escaping, all supporting timbers and the soil underneath being absolutely dry. Such a condition tends to longer life of the flume, and to secure it should be the aim of design and construction.

Slipperiness Test Pavements

The State Highway Commission of Massachusetts under a special appropriation of the legislature has recently completed the construction of ten sections of test pavement, the purpose of the experiment being ostensibly to determine the relative slipperiness of the various types of construction and to develop a pavement least objectionable to the horse owners of the state. Incidentally, it is expected that the experiments will demonstrate other things of interest.

The test sections are on Washington St., Boston, Mass., near the city line, adjoining Dedham. The sections are 500 ft. long and are on 4% grades. Alongside the pavements is a waterbound macadam shoulder 6 ft. wide, the test for slipperiness being the readiness with which horse-drawn vehicles seek the shoulders of the various strips of pavement.

Section No. 1 is a "rough" tar penetration pavement—that is, constructed of a 3-in. layer of rolled No. 1 stone covered with 3 gal. of hot tar per square yard, spread in a single application. This differs from the regulation tar penetration macadam in that the tar is added in one application instead of two, the second application being generally known as the seal coat. Section No. 2 is a "smooth" tar penetration pavement that was built with the two applications of tar—that is, sealed.

The next section, No. 3, is concrete laid in the usual manner. Section No. 4 is a "smooth" asphalt penetration pavement, exactly like No. 2 except that a standard asphalt instead of tar was used as a binder. Section No. 5 is a "rough" tar mixture pavement. The paving mixture consisted of No. 1 stone, sand and tar in the following proportions by weight respectively—750 : 150 : 40. Section No. 6 is a "rough" asphalt penetration macadam, like No. 1 except that asphalt instead of tar was used for the binder.

For the following section, No. 7, a "rough" asphalt mixture was used, exactly like No. 5 except that asphalt was used instead of tar. Section No. 8 is a tar-sand grouted layer of No. 1 stone. The tar-sand grout was a 1 : 1 mixture and was poured hot over the rolled stones. The sand used was very fine. Afterward ½ gal. of tar per square yard was added as a seal coat. The tar grout filling required about 2.15 gal. of tar per square yard. Section No. 9 is a "Ma-Drite" tar macadam pavement, constructed after the manner described in *Engineering News*, July 8, 1915, p. 81 (hand-mixed tar and stone). Section No. 10 is a Topeka mix asphaltic concrete pavement. This section was put down by special contract, and it is not the equal of ordinary Topeka specifications pavements.

The only noteworthy points yet developed are that the asphalt mix, with coarse aggregates, tar mix and the rough penetration pavements have already required a seal coat to keep them from raveling under only two or three months' wear and that the macadam shoulders are next to impossible to maintain. The same kinds of asphalt, tar, stone and sand were used in all the sections, so that the variables are reduced to only the methods of construction.

The chairman of the Massachusetts State Highway Commission is William D. Sohier; A. W. Dean is chief engineer, and F. C. Pillsbury is division engineer of the third division, including Boston and vicinity, in which the above experiment is being tried.

Wayne Sewage-Disposal Works After Nine Years' Use

By G. Everett Hill*

SYNOPSIS—To economize space in a highly developed residence section and to save pumping the sewage, the broad irrigation works designed and built by Colonel Waring a quarter-century ago have given way to septic tanks, coke roughing and intermittent sand filters and hypochlorite treatment. The plant is described and some operating results are given.

Wayne is a residential community of about 1,000 population, on the main line of the Pennsylvania R.R., 11 mi. west of Philadelphia. Its natural drainage outlet is a small stream (normal dry-weather flow 0.69 to 0.87 sec.-ft.) known as Ithan Creek, which runs 4 mi. through a well-populated district—and for part of its course through large parked estates—to Darby Creek.

A system of sewers and sewage treatment was installed by the late Col. George E. Waring, Jr., in 1891.[1] Disposal was effected by irrigation upon 11 acres of land, divided into five tracts for use in rotation. Four acres of the field, divided into two tracts, was open meadow land, fed by gravity and used to treat the night flow. The day flow was pumped intermittently from a gravity-fed receiving tank to seven acres of wooded hillside, divided into three tracts. Before application to the soil the sewage stored in the receiving tank was thoroughly aërated by starting the pumps and opening a bypass that discharged the sewage, in a strong jet, back into the tank. In the light of recent activated-sludge developments it is interesting to note that the effluent was better when the tank seemed most in need of cleaning—that is, when the aërating jet mingled with the water the greatest amount of old sludge. This system of disposal operated—on the whole, satisfactorily—for 15 years.

In 1906 the writer advised the owners that developments in the art made it possible to reduce the size of the plant and to operate it entirely by gravity. Reconstruction was ordered, and the system now in use was completed and put in operation in September, 1907, under the writer's direction. It occupies the space formerly used for the treatment of the night sewage. During construction the entire flow was diverted to the hillside beds, which are now idle.

In a shallow chamber, built in the course of the main 12-in. sewer, the sewage passes through a screen (normal wetted area, 7.5 sq.ft.) made of bars with $2\frac{1}{4}$ in. clear spacing. This inclines 10° from the vertical, so that the operator, standing on the ground at the outlet end of the chamber, can rake the accumulated deposits up the screen to a perforated sheet-iron plate, suspended over and draining into the outlet channel. Adjoining this drain plate is a small chamber, in which the drained material, sprinkled with a little lime, is stored until a convenient time for removal. This screen chamber is intended to retain nothing but the bulky and resistant solids that are foreign to true sewage—but which every sewer carries. Some paper is removed; but most of it, if it does not pass the coarse screen immediately, is ultimately shredded and carried away by the flow.

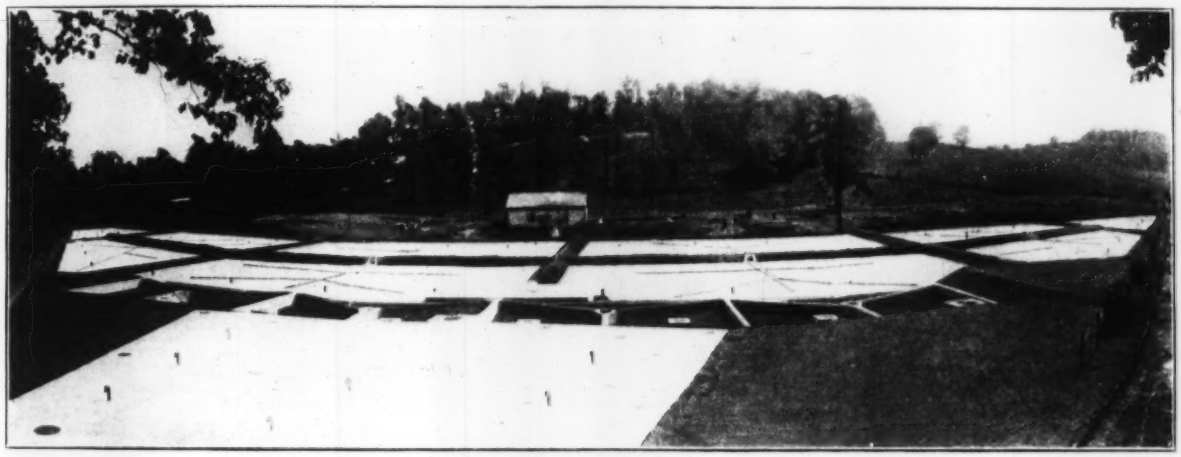


FIG. 1. GENERAL VIEW OF SEPTIC TANKS, ROUGHING AND SAND FILTERS, WAYNE, PENN.

Digestion or One-Story Septic Tanks

From the screen chamber the sewage passes to the digestion tanks. These are three one-story concrete chambers, roofed with reinforced concrete, lying in the foreground of the general view of the plant, Fig. 1.

The inlet feeds (Fig. 2) have three right-angle turns that check the speed of the incoming sewage, and the last bend delivers horizontally, below the scum and above the sludge, backward *against* the wall of the tank, which acts as a diffusion plate and spreads the liquid (like cigar smoke blown gently against a wall) in all directions—securing immediate loss of velocity, good distribution and uniform displacement of older sewage. This form of

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[1] See "Engineering News," Nov. 3, 1892, pp. 422-424, for illustrated description; also Jan. 4, 1894, p. 16, for remarks in an article by Colonel Waring.

inlet was determined after experimental study of many types in glass tanks filled with clear water and fed with varying mixtures of water, sand, finely powdered clay and aniline dye. The flow to each inlet is regulated by an adjustable diaphragm consisting of a set of nested concentric iron choke rings.

The outflow from each tank (Fig. 2) is over a smooth dead-level weir wall (protected by a scum-retaining apron wall) that extends across the whole outlet end. This type of outlet insures the escape of the sewage without the increase of velocity that would be induced by the use of a point or points of outlet. It maintains a uniform cross-section flow from wall to wall, and because of its great relative length the liquid creeps over it in a film so thin that it cannot float even the smallest masses of digested sludge. When these rise beyond the apron wall, they strike and stop at the weir wall, until they are

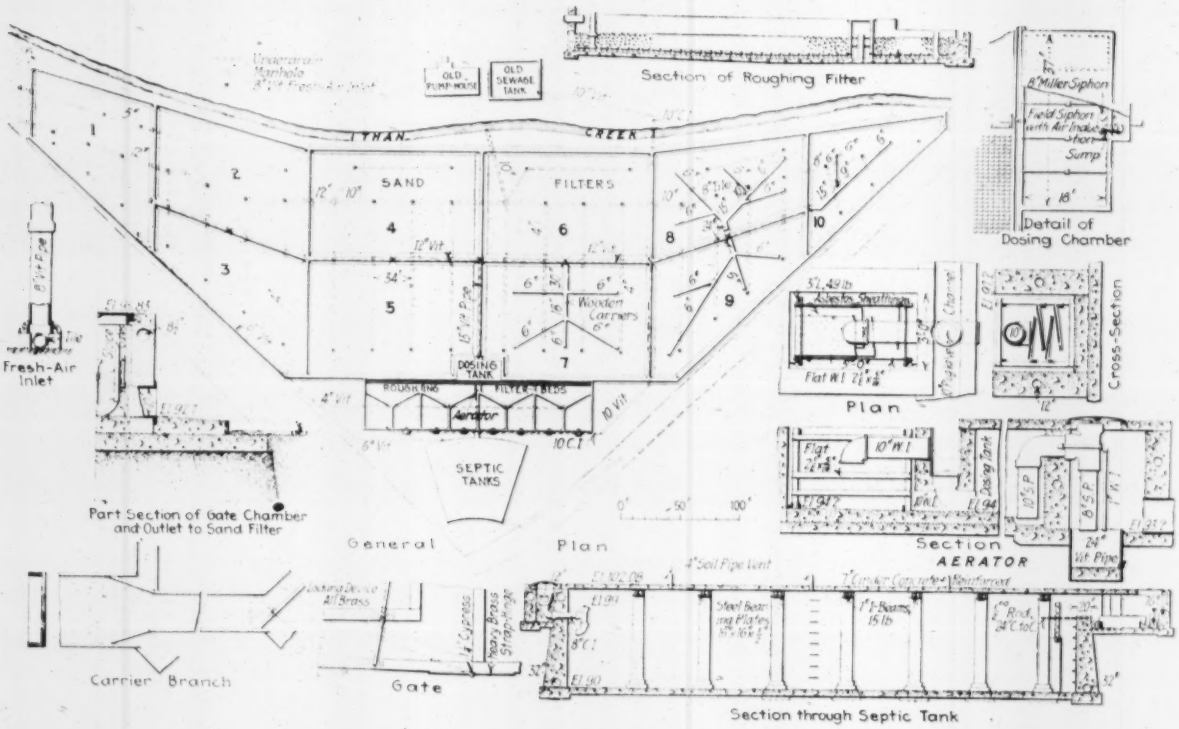

FIG. 2. PLAN AND DETAILS OF SEWAGE-TREATMENT WORKS, WAYNE, PENN.

disintegrated and carried away by the flow in subdivided form so fine that no individual particles can be distinguished, and faint momentary discoloration—such as might be made by a drop of ink—is all that is apparent.

Each tank has an area of 1,260 sq.ft., a working depth of 9 ft. and a capacity of 85,000 gal. In plan, the tanks form a sector of an annulus with a short radius of 86.11 and a long radius of 146.11 ft. Partitions as well as side walls are radial. Sewage enters at the narrow end and escapes at the broad end of each chamber, and the ratio of these ends is practically as 10 to 17.

Studies of Sedimentation and Sludge Digestion

Experimental study of a tank of this form, in conjunction with another tank of the same depth and capacity, but built with parallel side walls, showed about 18% superiority in sedimentation efficiency and a distinct advantage in digestive power. The former is doubtless due to the fact that light flocculent particles, which would be carried out of the tank by the *average* velocity of flow through it, settle in the less-than-average velocity of the wider outlet end. The gain in digestive ability may perhaps be due to the elimination or reduction of bacterial organisms by the deposition in different zones (due to diminishing velocity) of the heavier and the lighter solids and the resultant tendency toward segregation of the many different kinds of reducing organisms, each preferring some special food.

Experiments in anaërobic decomposition, made by the writer in 1900, showed more complete digestion of *total* organic matter when three successive withdrawings of settling sewage sludge were rotted in three separate vessels than when an equal amount of the same sewage was settled and septicized in one tank. The marked advantage of the segregation of the different kinds of *aërobic*

bacteria was recognized as early as 1890 and was brilliantly demonstrated by Scott-Moncrieff. Rideal in his "Sewage and Its Purification" (p. 100, third edition) wrote, "The best conditions are attained when a sewage plant is so arranged as to afford separate areas favorable to groups of organisms which work similarly." Like results have since been noted by Dr. Schmeitzner, who in his book, "Clarification of Sewage," calls attention to the 49.3% removal efficiency of a tank at Sheffield with parallel sides and uniform velocity, as compared with 82% removal efficiency of a tank at Viersen, similar save in that it has diverging side walls. The performance of the Wayne tanks, cited later, seems to justify the construction.

The outlet channel of each digestion tank is fitted with a slate knife-edge measuring weir. Two tanks are devoted to the treatment of normal dry-weather sewage. One is used at a time. When sludge ebullition becomes

marked, the flow is diverted to the other tank, in which, during its period of rest, ebullition has usually subsided. The third tank is held in reserve, to act as an equalizer when heavy rains (which find their way into the main sewer in spite of careful construction) increase the volume to an extent that would agitate the sludge or impair sedimentation in the dry-weather tanks. When the abnormal flow has ceased, the storage tank is bled slowly to a sand filter.

Down-and-Up Flow Primary Filters

From the digestion tanks the clarified sewage passes to coke-filled primary filters of the down-and-up-flow type. Their function is merely to withhold mechanically the finely divided or the semiliquid gelatinous substances not detained by the digestion tanks, which, if allowed to pass to the sand beds beyond, would cause unnecessary clogging and raking. As the downflow side of the primary filter collects by far the greater part of the sediment, eight downflow beds are provided and only four upflow beds. The septum walls, separating the down and up compartments, are so arranged (see section) that an up bed can be used in conjunction with either of its two tributary down-beds without any setback of liquid into the other down-bed. The average depth of the beds is 2.75 ft., and the total primary area is 0.1676 acre. Ordinarily two down-and-up units are in use at once, while six down and two up beds are draining (to a special sand sludge bed), aërating and reducing their accumulation of fine sediment. The effluent from the upflow beds passes over a weir wall into a channel that leads to a dosing tank, either directly (in winter) or (in warm weather) over a vertical series of sloping perforated aërating plates of asbestos board.

The dosing tank holds 10,000 gal., and it feeds the sand beds through either one of two 8-in. siphons—the first, a Miller, for use in cold weather, when it is desirable to conserve whatever heat the sewage has; and the second, for summer use, a Field-Waring fitted with a special air-induction device that sends the whole flow to the sand beds bubbling and foaming like soda water.

Ten sand beds are provided, with a combined area of 2.33 acres. They are 3 ft. deep and filled with clean quartz sand, brought from Cape May, N. J. The effective size of this sand ranged from 0.25 to 0.35 mm., and the uniformity coefficient never exceeded 2.5. The arrangement of distributing gates and carriers is shown in portions of Fig. 2. All beds are amply underdrained. Two systems of tile were installed, each collecting the flow from five beds and discharging through a separate outlet into Ithan Creek. Normally two sand beds are flooded daily, while eight are draining and aërating. No bypass to the creek exists. It is structurally impossible for sewage to reach the stream without passing at least through the sand. The structural cost of the plant, including engineering, was $81,335.

The present dry-weather flow is from 450,000 to 500,000 gal. a day. The average periods of detention are: In digestion tank, 4.3 hr.; in primary filters, 33 min.; in dosing tank, 30 min. The average horizontal velocity in the digestion tank is very low, only 0.004 ft. per sec. The rate of application to the sand beds—whole area—has averaged a little over 200,000 gal. per acre per day; to the beds in use, something more than 1,000,000 gal. per acre per day. This is a good index of the thorough clarification of the sewage before application to the sand. No sludge was removed from the digestion tanks between September, 1907, when they received their first sewage, and May, 1915, over 7½ yr. A conservative estimate of the amount of actual suspended matter received in this time is 1,200 tons. Of course, not all of this was destroyed. Much of it passed out in comminuted form and was caught by the primary filters, and some of it was detained and sent to the sludge bed (with the primary drainings) by a primary that was emptied of its coke and used for a time experimentally as a secondary settling basin. But the total mechanical removal of solids from any part of the system has been the rakings from the sand beds, averaging 2½ wheelbarrow loads a day, a small indeterminate amount washed at long intervals from the coke of the primary filters, and the deposit taken from the tanks in 1915, which was 617 tons of *wet* sludge, containing from 30 to 60 tons of actual solids. The rest has disappeared.

The primary filters have been cleaned by washing the coke about once in two years. The cost of washing each filter is about $60. Neither coke nor sand has ever been renewed.

Hypochlorite treatment of the effluent was added, after the plant had been running for some years, as another factor of safety. Thirty-five pounds of chemical is used per day, and the time spent in mixing, adjusting feeds, etc., averages about one labor-hour. The solution is fed directly into the eastern effluent drain, just above its outlet into the creek. The western (the upstream) drain receives no individual treatment, but it and the entire creek benefit by the treatment after mingling with the lower effluent, as is clearly shown by the following average of 11 weekly representative bacterial analyses:

	Bacteria Per c.c
Creek above the plant	324
Upper effluent (not treated)	17,337
Lower effluent (chemical just introduced, no time for contact)	343
Creek below plant	243

Weekly chemical analyses show that the effluent is uniformly stable in character, with an excellent degree of nitrification and containing abundant dissolved oxygen. The plant is regularly inspected by the Pennsylvania State Department of Health.

The disposal field, which is flanked by handsome residences and golf links, has been parked and is kept in beautiful condition. Three men are employed constantly in caring for the sewers and disposal plant, but more than half of their time is spent in maintaining lawns, trimming hedges and in other gardening operations. An extra man is occasionally needed. The total cost of operation (not including interest and overhead charges) is about $3,000 a year.

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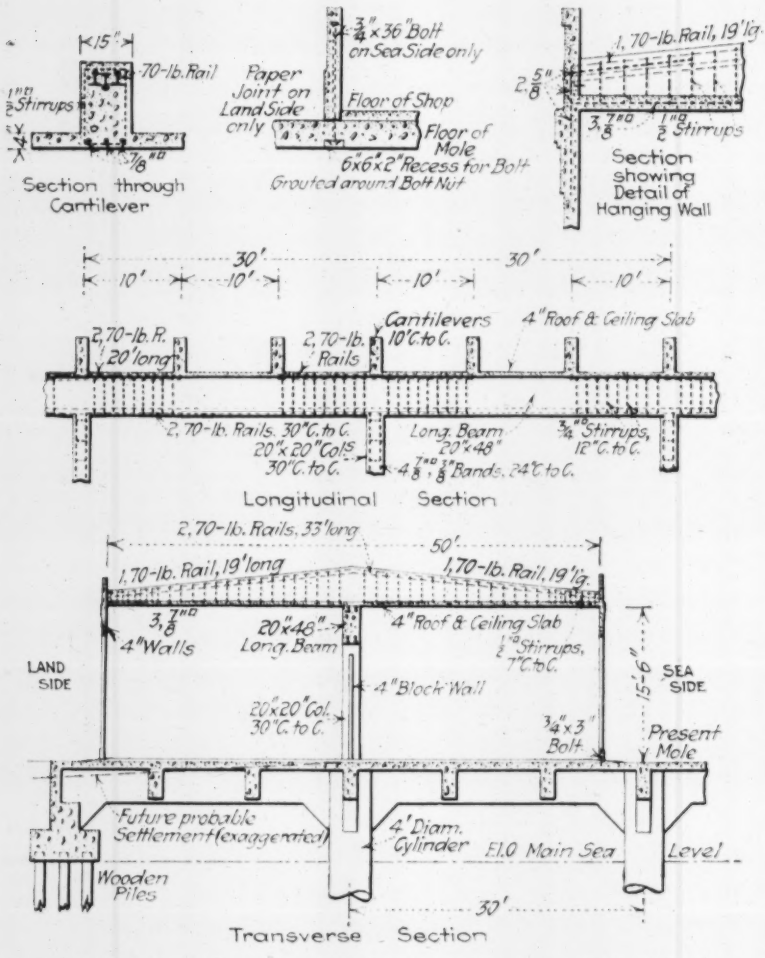
Engineers and Salesmanship—At the recent organization of the Salesmanship Club at Kansas City, Mo., Malcolm Lowry, of Hemicsi, Kent & Lowry, engineers, said in part: "The engineer needs salesmanship as well as the merchant or manufacturer. The act of selling is just as essential a feature of the business, whether the thing to be sold is a tangible piece of goods, or an intangible service. The engineer with the best equipment and organization in the world, the best potential service, is helpless without the sale of his service—just as useless a barnacle as the merchant with an unsold stock of goods. Life insurance men want to see the selling of insurance put on a higher plane, for the lasting benefit of their profession. And it is just as necessary that the selling of engineering service be done by competent men, that the buying public may be kept properly informed as to what engineering service is, and what is offered."

Concrete Building Balanced on Middle Line of Columns

By R. C. Hardman*

A reinforced-concrete repair shop and electric charging station now under construction at Cristobal, Canal Zone, has some unique features of design to meet unusual conditions. The building, which is being erected upon the mole between piers 8 and 9, is 51 ft. 4 in. by 271 ft. 8 in. in plan and one story in height. The mole, constructed in 1913, as will be seen in the accompanying plan, is founded upon piles and cylinders. The piles are of wood and the cylinders of steel filled with concrete. Since being put into use the wooden piles, which are under the inner or land side of the mole, have shown a small amount of settlement, while the steel cylinders have remained at their original elevation. Although this settlement was very slight and not sufficient to cause damage to the mole structure, its presence and the possibility of its future increase were subjects for consideration in the design of any structure to be built upon the mole. The new building is so placed upon the mole decking that one of its longitudinal walls is nearly over the line of piling on the land side. As it was not desired to place any additional load on this side of the mole, it was decided to suspend the walls from the roof. In addition to relieving the mole from the extra load, any possible damage to the building due to further settlement of the piles was also obviated.



BUILDING ON MOLE AT PANAMA IN WHICH SIDE WALLS HUNG FROM ROOF BEAMS

The type of structure selected is shown in the accompanying drawing. A single row of columns spaced 30 ft. on centers and located directly over one of the rows of cylinders supporting the mole establishes the longitudinal center line of the building. A large continuous beam connecting the tops of the columns carries transverse cantilever beams, which are spaced on 10-ft. centers. From the ends of these cantilevers are suspended the light 4-in. reinforced walls, which rest directly upon the mole deck, although their weight is carried, theoretically, by the cantilevers. Thus, it will be seen that the entire building (except the floor) is carried by a single row of columns on the center line of the building. While this is true under normal conditions and from a theoretical standpoint, practically the entire weight of the building is carried as would be the case in a structure of ordinary design—namely, by walls and columns. The designed action of the cantilevers will be secured only in case of further settlement of the wooden piles without corresponding settlement of the steel cylinders. Even with such further settlement the building would be in equilibrium about the row of columns unless it received wind pressure or other lateral force, in which case the tendency would be for the whole structure to move about the base of columns. To obviate the overturning result of the two stated conditions, the wall on the sea side is anchored firmly to the deck of the mole, so that under settlement and wind no damage would occur. It is not expected, however, that these anchor bolts will be called upon to serve their purpose, as settlement will be followed by the grouting-up between building wall and mole deck. Details are also shown of the various sections of beams, methods of wall suspension and roof and ceiling slab. The ceiling slab, it will be noticed, by being pitched for drainage also serves as a roof. Attention is called to the use of 70-lb. steel rails as reinforcing material. Since the watering of the canal prism enormous quantities of these rails have been scrapped and are being extensively used wherever possible because of their relative cheapness.

The building has been designed and is being constructed by the Building Division of the Panama Canal.

*Balboa Heights, Canal Zone.

Linking Up British Power Stations—A joint committee of the associations of electric power companies and municipal electric undertakings has been formed to study the general interconnection of power stations throughout England, Wales and Scotland. This is urged to save fuel, increase security of supply, future economy of investment, etc. The country has been divided into 16 districts in each of which a local sub-committee of engineers is studying (or will shortly) particular problems of the locality.

Side Lights on Depreciation Problems of Utilities--I*

By Harry Barker†

SYNOPSIS—A review of the many meanings applied to the word "depreciation" and a proposed system of definitions to remove existing confusion. A new term is offered, "retirance"—annual repayment to compensate for depreciation. A subsequent article will deal with plans for computing annual depreciation and retirance.

"Depreciation" is a term that has been too loosely employed. The meanings given to it are seen to fall into two general classes: (A) Losses in value of physical property, and (B) sums secured from earnings to offset loss in value of property.

The first group of definitions of "depreciation" is further divided into: (1) Aggregate actual or estimated loss in value from all causes, (2) the loss of value due to wear- and age-deterioration as distinguished from the loss of value from liability of obsoletion or inadequacy, (3) the loss in value due to loss of ability to render full service or to decreased efficiency.

The second group of definitions is seen to be split into: (4) An annual accounting figure representing the depreciation for the year, or any other given period, deducted from gross earnings in computing probable true net earnings; (5) an annual sum used in making up the amount of necessary income to be secured by the rates. This last is often an annual amount to be set aside out of the earnings to help create a reserve which will equal the cost of the several items of plant when they are retired from service, and will pay for the renewals to the extent of the cost of the items retired. It might well be a direct repayment out of earnings of investment, equal to the annual loss in value of property due to depreciation. There is a final observable definition of depreciation as (6) various aggregates of the annual sums secured from time to time to compensate for loss in value through depreciation.

The various shades of meaning indicated in these definitions explain the extreme confusion which has been introduced into discussions of depreciation and the need of greatly restricting the use of the term. Language is not so impoverished that it is necessary to use the single word in so many senses.

"Depreciation" Properly Used

The first definition—as the aggregate loss in value from wear-deterioration, inadequacy, supersession, antiquation, dilapidation, etc.—is probably the most used and the original one. This can well be adhered to, and a few available terms employed to carry the other meanings given.

The idea involved in the second definition makes a most useful distinction which should be preserved, but it is more definitely indicated by "wear-deterioration," "age-deterioration" or "wear- and age-deterioration," according to the precise shade of meaning needed.

The third definition—loss in value due to diminished power to function or to decreased efficiency—has no real place in depreciation discussions, for mere ability to render the original service does not indicate lack of depreciation, and percentage of service ability (which is not the "serviceability" of the dictionary) alone does not measure value. (It indicates relative value only when the duration of that percentage of service ability is considered; if one machine can yield certain service for 10 years and a second machine can yield the same service for 20 years, their real values are not equal.) Instead of speaking of this loss of service ability as depreciation it should be called "service-ability drop" or some equivalent.

The fourth definition has sprung up to give a short expression equivalent to "deductions for depreciation expense," or something like that. If there were not so many definitions in the field needing weeding out, its abbreviation to "depreciation" would be excusable. But, because of the confusion induced, the longer phrase should be reverted to.

Similarly in the case of the fifth definition it is advisable to say "allowance for depreciation expense," or more briefly "depreciation allowance," and not merely "depreciation." Between speed of speech and accuracy of expression there should be no question of choice. Depreciation allowances correspond to what some engineers call a "theoretical depreciation" in contrast with what they designate as "actual depreciation" (meaning wear-deterioration) found by examination.

A New Term Offered

Definition five conveniently reduces to "renewal allowance" and for further simplicity to the coined word "renewance," which the author has found generally understandable. The first and the fifth definitions are perhaps the ones most used, so that it is a great advance to agree to speak of "depreciation" as the actual lost value, and "renewance" as one year's part of the compensation therefor.

However, it is little more than a convenient fiction to speak of building up reserves for renewals, since those funds have no relation to the amounts spent for the new equipments. Electric railways have been known to scrap generating equipment and purchase power from central-station companies, notable examples being the Cleveland (Ohio) Railway Co. and the Third Avenue Railway Co., in New York City. In general, replacements are made with radically different apparatus. What the business must be made to yield, in line with the Supreme Court's dictum, is full compensation to the utility concern for the loss in value of property from all the various causes already outlined. That is to say, *the rates must cover the liability for retiring plant rather than the cost of renewing it.* "Retirance" therefore has been substituted for "renewance." Retirance then is the

*Advance publication of parts of a chapter from a forthcoming book, "Public Utility Rates," to be published by the McGraw-Hill Book Co. Copyright; rights reserved. In part based on the author's discussions at the Philadelphia Valuation Conference, November, 1915, and American Society of Mechanical Engineers, December, 1916.

†Associate Editor, "Engineering News," New York City.

annual amount to be repaid the corporation to compensate it for each year's depreciation. Retirance is a definite factor in rates and in its nature is a repayment of invested capital. Unit retirance may be spoken of as a subdivision of retirance as it has been apportioned over rates. Wear-retirance, age-retirance, obsoletion-retirance, etc., become useful special terms which can be accurately employed. The place of aggregate retirance is obvious.

By such a restriction as outlined on the employment of the terms "depreciation," "wear-deterioration," "depreciation-allowance," "retirance," etc., discussion is not appreciably encumbered and a fundamental cause of exasperating confusion is removed.

Retirance a Repayment of Lost Investment

Whether or not the retirance money secured out of rates can be regarded as a repayment of investment is one of the most debated points that has arisen. Careful consideration of the question (keeping in mind the fundamental idea that loss of investment, impairment of capital or assumption of liability for renewal must be compensated by the customers in whose service the loss, impairment or assumption arose) will seemingly leave little doubt that the retirance collected is a restoration of balance between physical assets and incurred liabilities (including stocks and bonds). That looks like repayment.

However retirance cannot be a direct repayment when it is purposely made smaller than the annual depreciation with a view to placing it in a sinking fund and obtaining the normal amount through accumulations of interest. In this case the retirance is not free capital which the owner of the property may put in service to swell his income; all the earnings must be retained to complete the retirance fund, which can be drawn on only when an item has reached its assumed length of life.

Appraised Value, Depreciation and Retirance

It is the actual depreciation which in the long run affects real profits—considering actual values preserved as well as net earnings secured. But it is retirance which determines the computed, and approximated, profits and possible dividends from quarter to quarter or year to year. The annual increment in actual depreciation is not necessarily the same as the annual retirance sum which is intended to cover it, though that is the ideal sought. The most that can be said is that the aggregate of retirance accumulated on an item of property plus the scrap value should equal the total first cost when the item is discarded—no sooner, no later. Few can estimate so happily as to have their first estimate of retirance continue to the end without readjustment. If an examination of a piece of apparatus showed that the aggregate of contributions made against its retirement is going to be too large, then they might be decreased to such an amount as will probably complete the return of cost at the end of the useful life of the item, except that the rates should be held steady rather than fluctuating. The reverse adjustment would be necessary if the aggregate of allowances for a number of years proved to be less than the actual decrease in worth shown by examination. This adjustment affects dividends and surplus rather than stable rate schedules.

The exact eventual return of cost through retirances can be simply secured with the sort of accounting required by the Interstate Commerce Commission. In following its rules, monthly charges against depreciation are made, based on expectation of life. If an item lasts longer than anticipated, the retirance charges stop when 100% of its cost has been reached. If the life for any reason is shorter than expected, the unreturned balance is used to swell the depreciation-expense account for the year, or for large sums the balance is put into a suspense account and spread over several years.

It must not be expected that the valuation figures of a property, even though based on a good appraisal, plus the aggregate of all retirance moneys secured out of rates, will any more than roughly approximate the reproduction cost of the property or the legitimate investment historically established. The reasons are fairly obvious. Among other things, the value may be based on changing unit prices; appreciation of property may enter. The retirement allowances, as assessed on customers, are weighted composites for the various items that make up the whole plant. With uniformity and stability of rates over a given short period of time, the annual retirance at first would usually accumulate faster than *observable* composite depreciation would accrue. The deterioration of machinery seems to become more obvious in the last years of its service that in the earliest, and part of the retirance covers an antiquation which descends swiftly and, though impending, may not be seen by the superficial appraiser.

Failure to Collect Retirance

Where retirance money has not been collected, through the error and oversight of officials or neglect to charge sufficient rates, then according to the Knoxville case decision the company still is entitled to earn only on its depreciated value of property. This view has been assailed by many prominent engineers, and the hope has been cherished by them that the Supreme Court would reverse itself. It is of interest therefore to examine this part of the decision in question (City of Knoxville vs. Knoxville Water Co., 1909; 29, Sup. Ct. Rep. 148) to find its basis in law and economics.

> The company's original case was based on an elaborate analysis of the cost of construction. To arrive at the present value of the plant large deductions were made on account of the depreciation. This depreciation was divided into complete depreciation and incomplete depreciation. The complete depreciation represented that part of the original plant which through destruction or obsolescence had actually perished as useful property. The incomplete depreciation represented the impairment in value of the parts of the plant which remained in existence and were continued in use. It was urgently contended that, in fixing upon the value of the plant upon which the company was entitled to earn a reasonable return, the amounts of complete and incomplete depreciation should be added to the present value of the surviving parts. The court refused to approve this method, and we think properly refused.
>
> A water plant with all its additions begins to depreciate in value from the moment of its use. Before coming to the question of profits, the company is entitled to earn a sufficient sum annually to provide not only for current repairs, but for making good the depreciation and replacing the parts of the property when they come to the end of their life. The company is not bound to see its property gradually waste without making provision out of earnings for its replacement. It is entitled to see that from earnings the value of the property invested is kept unimpaired, so that at the end of any given term of years the original investment remains as it was at the beginning. It is not only the right of the company to make such a provision, but it is its duty to its bond and stockholders, and in the case of a public-service corporation, at least, its plain duty to the public. If a different course were pursued, the only method of providing for replacement of property which had ceased to be useful would be the investment of new capital and the issue of new bonds or stocks. This course would lead to a constantly increasing variance between present value and bond and stock capital

ization—a tendency which would inevitably lead to disaster either to the stockholders or to the public, or both. If, however, a company fails to perform this plain duty and to exact sufficient returns to keep the investment unimpaired, whether this is the result of unwarranted dividends upon over-issues of securities or of omission to exact proper prices for the output, the fault is its own. When, therefore, a public regulation of its prices comes under question, the true value of the property then employed for the purpose of earning a return cannot be enhanced by a consideration of the errors in management which have been committed in the past.

This statement is seen to be based on the proposition that for every dollar by which the property has depreciated, the company is entitled to earn a dollar above interest and profits. When this is done, each item is repaid as it is retired and existing depreciation is made good each year. If it should not be done, in the course of time replacements would have to be made out of entirely new capital and that would be an economic sin against the next generation.

This is a statement of general principle evidently intended as broadly applicable—since there are no references to the effect of peculiar conditions disclosed by the evidence in this case. So it must have been well considered before given that form and stated without exceptions. It is hard to find grounds therein for expecting its reversal *except* for those cases where the company has been constrained by local government or regulating commission to make rates that did not fully provide "for the replacement of its property out of earnings." Requiring a company to base rates on depreciated value of property in such cases would seem to constitute confiscation.

The same unfortunate result would be attained if the regulating authority had applied and continued to use the sinking-fund annuity in determining rates together with depreciated value of property. The sinking fund is not free capital; it brings the company no dividends by its investment and the concern gets no return on part of its investment where the equivalent of full value is not retained in the rate basis.

If rates have been based on full value and retirance has been secured by sinking-fund annuities, the regulating authority could follow two courses. First, they could continue as before to use the sinking-fund annuity for retirance and full value of property on which to figure return; or they could follow the Knoxville dictum and use depreciated value provided retirance was made fully equal to computed annual depreciation henceforth; the accumulated sinking fund properly handled would equal the depreciation up to that time and would then become free capital.

The last sentence quoted from the opinion lays stress on the errors of management which cause or permit insufficient rates. It is not to be assumed that the same interdiction applies to the many cases where the business could not have struggled along in its earlier stages had the charges been large enough to satisfy this demand—customers would have been driven away instead of being encouraged to increase to the point when the same rates yielded all the proper sums without being burdensome. Error and incompetency, not mere force of circumstances, are to be penalized, if a strict sense of equity is to be preserved—and that surely was what the court sought. Therefore, the inclusion of deficits between the actual and what would be proper returns to cover depreciation may be retained in development expense—or what some call "going value."

Some Items Affecting Cost of Structural-Steel Work

Views of structural-shop engineers on the factors affecting costs of shopwork were given the Engineers Society of Western Pennsylvania on Oct. 31 by E. W. Pittman, Manager of the Rankin Plant of the McClintic-Marshall Co., and George H. Danforth, Structural Engineer for Jones & Laughlin Steel Co. One of those discussing the papers later thought that Mr. Pittman was venturing into fields of humor when the statement was made that the designing engineer "has a creditable ambition to produce something original and to specify the best of materials and workmanship and at the same time is conscious of an obligation to his client to keep the cost of the structure within reasonable limits." Mr. Danforth was a little more blunt in stating that "some designers seem to think more of building a monument or of establishing a reputation for a wonderful design than they do of making a simple piece of work that can be readily built of easily available material."

Simple Details Desirable

In Mr. Pittman's judgment the design of a structure is the largest single factor in determining the cost per pound of structural steel, rather than any special or unusual requirement as to workmanship. The use of simple sections and few members in the place of complicated work often makes for a reduction in cost, even though the total weight may be somewhat increased. Both speakers emphasized the importance of using as few sections as possible in one job, and those to be sections frequently rolled, as both time for fabrication and the shop costs are reduced thereby. Both also referred to the disadvantages arising from the use of two sizes of punched holes in a single member.

The sequence of operations in putting work through a modern shop was outlined and the influence of design and specifications on the cost of these steps pointed out. In the discussion some difference of opinion developed as to how much in detail the engineers' drawings should be. Samuel E. Duff held that simple general drawings with good specifications were best, leaving details to the contractor, who could make them to suit his shops and tools. Paul S. Whitman, on the other hand, advocated complete design drawings, showing the number of rivets, even, in all important connections, on the grounds that the "average draftsman is a good spacer of rivets, but nothing more" and has little conception of the elements of design or the number of rivets required for good connections.

Design Drawings Should Be Complete

Another engineer with fabricating-shop experience, G. W. Nichols, agreed that design drawings should be complete, as this avoided the necessity for the fabricator to add a percentage to cover what the engineer might require and made all bids on a comparative basis. R. A. Pendergrass referred to the annoyance and expense often caused the drafting room by incomplete general drawings, from which essential information as to what the designer desired was lacking. He also mentioned an interesting case of shop drafting-room revision of a design where Bethlehem H-columns spliced at every floor were changed to three-story columns with but a slight increase in weight and a marked economy in shop operations and final cost.

Altering the Columns in a 21-Story Skyscraper

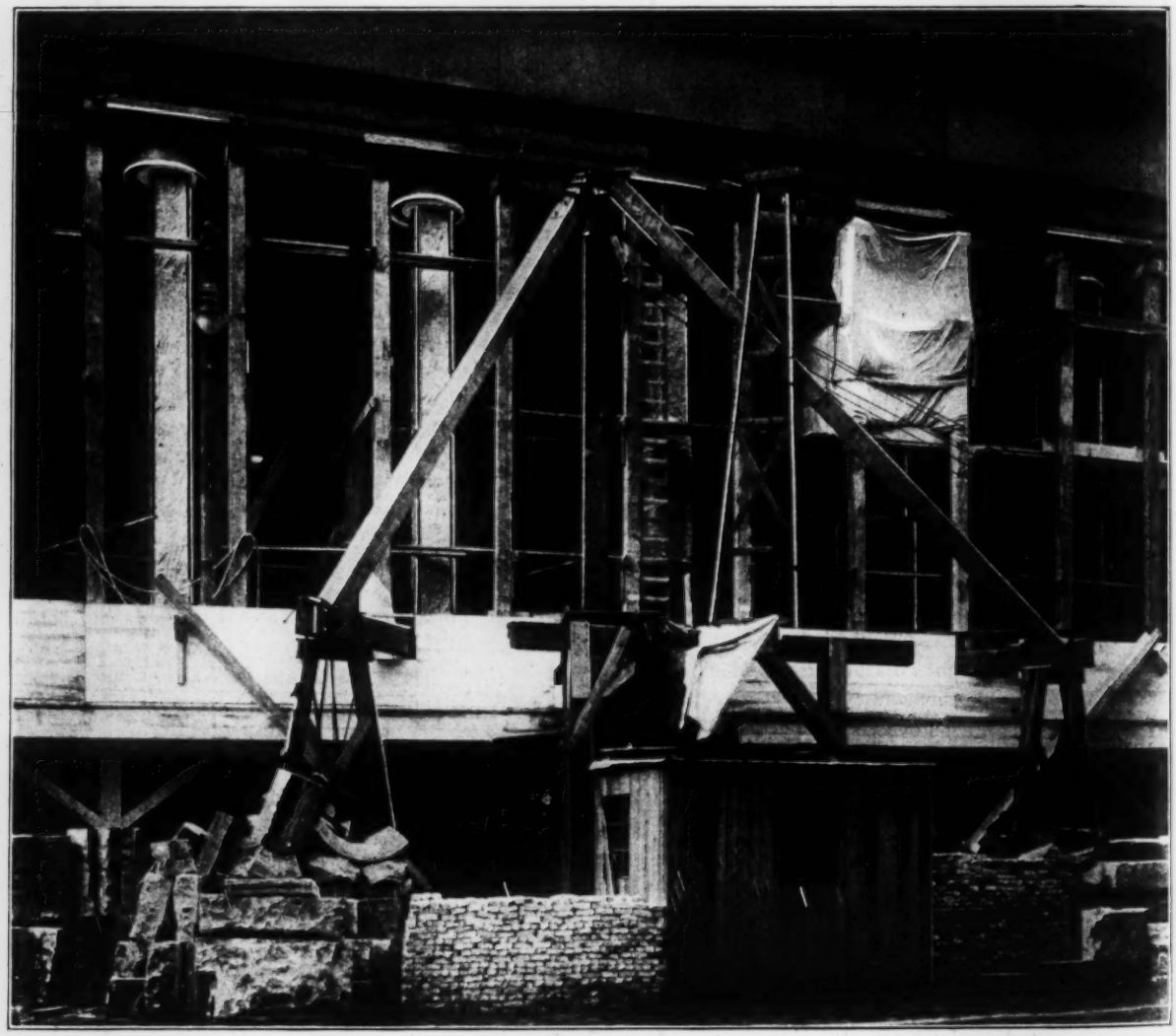
The 21-story Continental and Commercial National Bank building, one of the largest office buildings in Chicago (324x166 ft. in plan), has had interesting alterations made in the lower stories to obtain additional floor space at the sacrifice of the original architectural treatment. The building was described in *Engineering News*, Nov. 13, 1913.

The main front on La Salle St. was built originally with a loggia extending to a height of 45 ft. (nearly four stories) and with a depth of about 15 ft. (or the spacing between the outer columns and the first row of interior columns). In the front of this loggia the steel columns were concealed in red granite pillars, 11 ft. high, with capitals supporting the outer wall at the building line. These steel columns are of very heavy construction, owing to the great unsupported length and the loads carried.

To meet the requirements for additional space on the bank floors, it was decided to eliminate the loggia, and extend the floors and front wall to the building line in the lower stories. The red granite columns have been replaced with gray granite fluted pilasters built into the new wall and fitted to the original capitals. The entrance to the building is now less significant architecturally, consisting simply of rectangular doorways opening upon the sidewalk.

The most interesting work was in regard to the change in the treatment of the columns. In the construction of the building the exterior steel columns in this side were erected to the height of the loggia, and then each was inclosed in a series of red granite rings slipped over the column and built up to form a pillar. These rings were 35 in. high, 4 ft. 9 in. to 5 ft. 4 in. exterior diameter, varying with the entasis of the pillar. The thickness was 5 to 8 in., the pillar being placed eccentrically to the inclosed column.

These pillars gave considerable trouble, as noted in *Engineering News*, March 11, 1915. They did not take a good polish, and an attempt was made to repolish them in place with a machine rigged up so as to slide vertically and also travel around the column. This apparatus was only used experimentally. More trouble developed after a winter's exposure, several of the granite rings being split. This was considered due to excess of moisture in the granite shell and the concrete packing.



ALTERING THE STREET-FRONT COLUMNS OF A CHICAGO 21-STORY OFFICE BUILDING
The old granite rings, now being removed, split soon after they were placed

The specifications called for each drum or ring to be filled with concrete as it was set, before setting the next drum. Owing to delay in delivery of the granite and to the fact that the beds of the drums were not in accordance with the specifications, there was considerable delay in the work, and the superstructure for the entire La Salle St. front was held up until the drums could be placed over the steel columns. As a result the drums were all set in place and then concreted instead of being filled separately. Shortly after erection, it was found that some of the drums were not in perfect alignment, and the contractor started to recut and repolish the surfaces. This process kept the drums wet until late in the fall, and consequently the amount of moisture in the stone and the concrete was increased rather than decreased after the erection. Some of the pillars which had not been recut or repolished showed no cracks.

Repair would have been difficult and expensive, as the rings could not be removed without cutting them apart. The adoption of the alterations, however, made it necessary to remove these pillars entirely. For this work a staging was erected over the sidewalk, and an electrically operated stiff-leg derrick was installed. Vertical cuts were made in each ring with pneumatic tools and hand chisels, and the segments were removed by the derrick. The concrete packing was then broken away, exposing the steel columns, so that the new framing could be attached to them. The work was completed by the building of the new exterior wall and the granite columns, the latter being formed by segments on the street side only (the other sides being incased in fireproofing and masonry).

This work is shown in the accompanying view. The column at the right is in its original state. The next one has the rings removed to a point below the staging on which men are at work (inside the canvas screen) cutting away the concrete filling. The middle column has this filling in place to just below the staging. The two columns at the left have been stripped, except for the concrete filling between the flanges. The original front wall is behind these columns. The new wall is between the columns, and in line with the wall above. In the street are piled segments of the granite rings.

The new granite was furnished by the Stanstead Granite Quarries Co., and placed by the Steven & Son Co. The alterations were planned by Graham, Burnham & Co., who were the architects for the building as originally constructed.

Slides in a Deep Street Cut

The deep cut made at Kansas City, Mo., to extend Main St. from 24th St. to Grand Ave. is at last being used, but only by street cars, after eight years of planning and grading. The cut is 2,400 ft. long, with a maximum depth of about 82 ft. and a bottom width of 90 ft. The magnitude and difficulties of this work, which is known locally as the "Culebra Cut," have been explained by articles in *Engineering News* of Dec. 10, 1914, and Feb. 21, 1916. The great trouble has been the serious and continual caving of the side slopes.

The contractor for the grading brought the street to the established grade and the full 90-ft. width, removing all slides as they occurred during the progress of the work and then removing all remaining ledges that appeared dangerous. His work was finally accepted, May 12, 1915. A sewer with catchbasins, manholes, etc., was then constructed up the center of the street, followed by telephone conduits and a double-track car line, completed in the fall of 1915. Bids were also asked for paving, but none were received, due to the risk involved in estimating the amount of subgrading.

During this time small slides were constantly occurring, and the shale under the rock ledge disintegrated, leaving large overhanging rocks. At about the time the car track was completed, there were several very heavy slides, bending the rails and breaking trolley poles. The car company refused to operate cars through the cut, and the city spent the winter in trying to compel the property owners to make the cut safe and remove the slides. The ordinary legal-notice procedure, which was effective where small amounts of dirt caved onto the sidewalk on other streets, failed of results. The only course left open, if the street was to be improved, was for the city to remove the rock and earth at an estimated cost of $60,000 and test the validity of its action by a court suit to recover from the property owners. It is an established point in Missouri law that a street cannot be graded twice to the same grade and tax bills issued against abutting property for it, but it is also law that a property owner cannot maintain a menace to public safety.

The $60,000 not being available, the city has spent about $1,200 in the past three months, lightly blasting and prying the overhanging ledges down into the cut. The street-railway company removed that which fell between its rails and began the operation of street cars. Only one building has been built on the street since it was graded, which is at the intersection of Main St., Grand Ave. and 27th St. Only two other lots (next to 24th St.) have been graded down. A small rock-crusher plant is located on the east side, and the Park Board is planning to spend a $100,000 bond issue in grading and terracing the 8½ acres of Station Park, which fronts the plaza in front of the new Terminal Station and abuts on Main St. between 24th and 25th St. No other improvements are planned at present.

The cost, to date, for the opening and grading of this exceptional street cut is as follows:

Damages paid to abutting property in a special benefit district on account of cuts made in first grading	$49,117
259,963 cu.yd. removed under first contract	193,347
Damages allowed on account of second cut	32,350
Cost of property acquired in widening street from 60 to 90 ft., assessed against a special benefit district	41,265
165,981 cu.yd. removed under second contract	178,642
Cost to city for breaking down dangerous ledges	1,200
Total	$495,921

We are informed that the city will probably bring suit to recover the $1,200 from the abutting property owners, and that if successful it will proceed with the removal of the slid dirt in the same manner. The court action is based on the usual notice that is served on property owners or their agents, setting forth that a menace to public safety and obstruction of the street exists and giving a reasonable time to have conditions corrected. The city threatens that otherwise it will do the work and assess the cost against the property.

A change has recently been made by Kansas City in the form of ordinance and proceedings in grading, by which it is expected to avoid not only extreme cases of slipping, like the Main St. cut, but also the minor ones that occur where cuts of more than 5 ft. are made. An easement has previously been condemned on private abutting property in

the proceedings for the grading of streets where embankments come, allowing the necessary 1 to 1½ slope to fall on private property. Now an easement, or privilege, is also condemned at the same time, allowing the city the right in grading the banks and including this cost in the cost of grading the street. Several grading cases under these new proceedings have gone through without opposition.

The fact remains that after an expenditure of nearly $500,000 and eight years' time this cut is being used only by a few street cars. If completed and improved, it will be one of the arterial streets between the residence and business sections of the city. Cuts and fills of over 30 ft. are common in Kansas City, and little difficulty has been experienced heretofore with slides, the soil (or soil and rock) standing nearly vertical indefinitely, as shown by numerous pieces on unimproved lots close to the business district. But the Main St. cut is of unusual depth and length and has the disintegrating shale ledge beneath the rock ledges.

Locomotive Crane for Heavy Concrete-Bridge Work

Massive concrete slabs are being used for the decks of bridges over streets on the Chicago track-elevation work of the Rock Island Lines. They are also replacing, to some extent, the through bridges that were used extensively throughout Chicago in the earlier track-elevation work. To handle these slabs and set them in place, a locomotive crane has proved to be very economical, both in facility of operation and low cost of erecting. A heavy crane of this type, purchased recently by the Rock Island Lines, is shown in the accompanying view. It combines the features found in the heavier type of locomotive wrecking cranes, together with special features that were introduced to adapt it to this particular purpose.

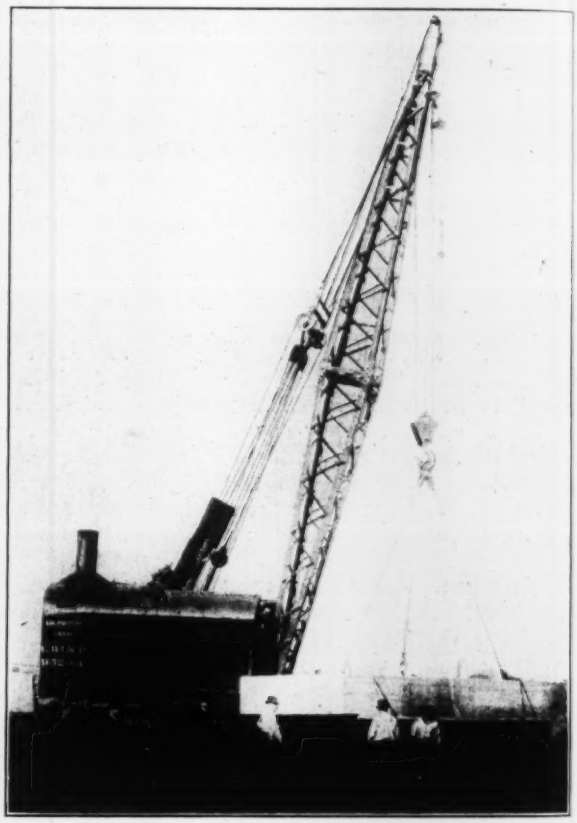
Design of the Crane

The crane is of steel construction throughout, mounted on extra-heavy trucks, similar to those used on the railway's 100-ton wreckers. Heavy outriggers or jacking beams provide excess stability when making side lifts at long reach. The boom is of the box-lattice type, with a bolted splice at the middle, so that the normal 50-ft. length can be increased to 70 ft. by inserting a 20-ft. extension. With the 50-ft. boom the hoisting capacity is about 50 tons at 20-ft. radius, or 13 tons at 50-ft. radius. The heaviest bridge slabs weigh about 50 tons.

Provision is made for attaching piledriver leads at the head of the boom, with a strut running from the foot of the leads to the base of the boom. This permits the machine to be adapted for piledriving on short notice and without the use of guys. The machine is also arranged so that it can operate a grab-bucket for excavating or unloading purposes.

This crane is designed primarily for high-speed erection, the intention being to provide the greatest possible capacity at long radii and to keep the weight of the machine as low as practicable and at the same time enable it to be used on other classes of work when not employed on the track-elevation bridges. To facilitate handling, air-operated clutches are provided, as well as a slewing motion of the selective type, having a slow speed for heavy loads and a fast speed for lighter loads. As much of the work of the crane is with light loads, this feature is of particular value. In addition to the boom hoist motion, there are four independent hoisting lines—the main hoist, auxiliary hoist and two winch heads. All these can be used for either hoisting or holding loads.

The machine is equipped with an electric turbo-generator with a capacity for running two 100-watt lights on the end of the boom and two 60-watt lights part way out on the boom, with sufficient provision for lights in the cab for the benefit of the operator. There are also two plugs on the outside of the cab, to which can be attached a flexible cord for operating a 1,000-cp. flood light on a



LOCOMOTIVE CRANE SETTING CONCRETE BRIDGE SLABS: ROCK ISLAND LINES

tripod, in order to permit the machine to work to advantage during the evening or night hours. An equalizer on the topping lift distributes any strains on the boom cables that raise and lower it. The machine is self-propelling and is so designed as to be used economically on construction and erection work.

The work on which this machine is used is under the direction of Robert H. Ford, Engineer of Track Elevation, Rock Island Lines. The crane was built by the Industrial Works, Bay City, Mich.

Artificial Gas made and sold in the United States in 1915 amounted to 266 billion cu.ft., according to statistics collected by the U. S. Geological Survey. The total value was $174,000,000. These figures represent an increase of 25% in quantity and 17% in value compared with 1912, the last preceding year for which statistics of this industry were collected. Of the total output, 43% was coal gas, 47% carbureted water gas and 13% oil gas.

Roof Slabs of 10-Ft. Span

A roof covering composed of gypsum T-beam slabs 10 ft. long, having a clear span of 9 ft. 8 in., is a feature of a steel-frame building 190x200 ft. recently erected for the Walker Manufacturing Co. at Racine, Wis. These long slabs have been designed as the outcome of numerous tests made at the University of Illinois by Willis A. Slater.

The slabs are of T-section, 15 in. wide and 8 in. deep, with a thickness of 1¼ in. for the top, or flange, and 2¼ in. for the rib. The ends are closed by diaphragms 15 in. wide and 2 in. thick. Each beam has two ⅜-in. rods in the bottom of the rib, one of these being bent up at the ends as a shear rod and looped so as to increase the value of the bond stress. In the top flange is embedded a steel-wire mat of No. 14 gage and 4-in. mesh. The weight is 16 to 17 lb. per sq.ft. The joints are plastered on the outer surface.

These beams were made at the site, in wood forms, at the rate of about 300 sq.ft. per hr. They only required 15 min. to set, from the time the mold was poured until the forms were knocked down. These beams were erected in place and walked upon within three hours after being poured. They were designed (upon the same principles as reinforced concrete) to carry a uniformly distributed live-load of 50 lb. per sq.ft. with a safety factor of 4. Tests of five sample beams 24 hr. old were made with loads of 2,200 and 2,400 lb., or 200 to 218 lb. per sq. ft., with respective deflections of 0.034 and 0.070 in. The total loads were then increased to 3,500 lb., causing slight horizontal shear cracks to appear, but without other signs of failure.

ROOF OF GYPSUM SLABS 10 FT. LONG ON STEEL FRAMING

In the roof construction these slabs, or beams, are carried by light steel trusses for the saw-tooth portions and by steel purlins, etc., for the flat portions, all of the supporting steel being spaced 10 ft. c. to c. In general the flat roof portion has a pitch of 1½ in 12, while the saw-tooth construction pitches about 7½ in 12. The architect for the building was P. L. Batty, Chief Engineer of the Arnold Co., consulting engineers, Chicago. The Arnold Construction Co. had the contract. The slabs were made under the direction of the United States Gypsum Co., of Chicago.

When a flat ceiling effect is desired, instead of the ribbed, or beam, ceiling formed by these T-beams, the slabs may be of H-section, with the top and bottom flanges of equal width. These weigh from 22 to 24 lb. per sq.ft. for the live-load noted above. In such a roof now being erected the beams weigh 22 lb. per sq.ft.

Power Loss in Screw Propellers Due to Rough Surface

In a paper read at the recent annual meeting of the Society of Naval Architects and Marine Engineers, Naval Constructor William McEntee, U. S. N., described a test made at the model basin of the Washington navy yard to determine the effect of the rough surface of a propeller on its efficiency.

These experiments indicate the great saving in power resulting where ship propellers are made of some non-corrodible metal like bronze and are carefully machined and polished, as compared with the ordinary practice of using propeller castings as they come from the foundry. It is likely that these experiments teach a valuable lesson, also, to the designers and builders of centrifugal pumps. The skin friction of a rapidly moving impeller in a centrifugal pump must be very great, especially in pumps working at high heads; and it seems all but certain that this skin friction must be greatly increased if the impeller is a rought casting.

The screw propellers used on naval vessels are customarily carefully finished by machining the rear surface of the blade to a true helicoidal surface and finishing by hand the front face so that it will be perfectly smooth. The propellers of merchant vessels, however, usually have blades of cast iron or cast steel and are given no finish whatever, except trimming off the rough places with a chisel or rough file. In addition, as is well known, iron and steel propellers often suffer by pitting, so that they present an extremely rough surface to the water.

In order to test the relative efficiency of a smooth finished propeller and a propeller left with the rough surfaces of the original casting, four 16-in. diameter propellers were made and tested at a uniform speed of 5 knots. Two of the propellers were of bronze, one of cast iron and one of cast steel. One of the bronze propellers was finished perfectly smooth; the other propellers were left as they came from the molds, with only the ordinary cleaning. The test showed that the propellers with a rough surface had a maximum efficiency of about 63%, whereas the polished propeller had an efficiency of about 72%.

In order to test the effect on propeller efficiency of a still rougher surface, such as exists on a propeller that becomes badly pitted or on which barnacles and other sea growths accumulate, the bronze propeller that had been polished was varnished, and to the sticky varnish there was applied a layer of granulated cork, such as is used for cork paint in ship work. The same tests were repeated with the propeller surface thus artificially roughened, and the maximum efficiency of the propeller, which had been about 72% in its polished condition, was reduced to 36%.

Engineering Literature

Dr. Waddell Makes Notable Addition to Bridge Books

AN ILLUMINATING REVIEW BY GUSTAV LINDENTHAL*

BRIDGE ENGINEERING—By J. A. L. Waddell, M. Am. Soc. C. E., Senior Partner of Waddell & Son, Consulting Engineers, Kansas City, Mo. In Two Volumes. New York: John Wiley & Sons. Cloth, 6x9 in.; pp. lxxv + 2,177; profusely illustrated. $10.

The latest addition to the literature of bridge construction is a work in two volumes by Dr. J. A. L. Waddell under the title "Bridge Engineering." In his preface the author describes the work as an expansion of his pocket-book "De Pontibus," first published about 18 years ago and followed five years later by a second, somewhat enlarged, edition. The new work is estimated by the author to contain about seven times as much matter and 30 times as many illustrations as "De Pontibus." Each of the two new volumes contains over 1,000 pages. The author states that the expense of getting out the book was $22,000 and that it contains the results of his 40 years of professional experience; the book is thus somewhat biographical in character.

The particular value of the work is derived from the fact that it comes from a practicing bridge engineer of wide experience and established high reputation. We all know how rare it is that a busy engineer can spare the time, effort and expense to incorporate his valuable practical knowledge in book form for the instruction and benefit of other engineers.

The scope of the work may be judged from the number of chapters. There are, in the two volumes, not less than 80 chapters, many of them being voluminous essays on their particular subjects.

The author does not profess to go to any extent into the theory of stresses in steel structures; instead he refers his readers to the standard works on bridges. In the long chapter on reinforced-concrete bridges (XXXVII), on the other hand, there is presented, along with well-known theories on beams, a method of computation of reinforced-concrete arches with fixed ends. Parenthetically it may be observed that most theorizing on concrete design pretends to greater refinement and accuracy of stresses than it seems reasonable to use with the coarse and variable character of the material as it occurs in practice.

NEW BOOK ON BRIDGE ENGINEERING JUSTIFIED

The usual questions about a new book are: (1) Does it contain new matter not found elsewhere? (2) Does it contain old matter, but treated more extensively? In this case both questions can be answered in the affirmative.

Some chapters comprise subjects not treated, or not as completely treated, in any previous works on bridges. For instance, Chapter I deals with the Evolution of Bridge Engineering, from the origin of bridge building to the present time, ending with a prognostication of future development. Chapter II is on the Bridge Specialist, with a definition of his duties and the necessity of retaining him. There are also chapters on Determination of Waterways; Requirements of the United States Government for Bridging Navigable Waters; Hydrographic Surveys; Expedients in Design and Construction; Office Practice; Triangulation, Erection and Falsework; Examination of Bridges; Bridge Failures and Their Lessons. There is a valuable chapter on True Economy in Design and one on Determination of Layouts. Then there is a chapter on Specifications in General and another on Contract Forms; one on Arbitration for Settling Disputes; one on the Promotion of Bridge Projects; and one on Business Features of Bridge Engineering. Engineers will derive satisfaction from a chapter on Fees, and for those who desire to practice what is preached there is a chapter on the Ethics of Bridge Engineering.

Of old and well-known subjects brought together and more extensively treated by the author, mostly from his own viewpoint, may be mentioned the chapters on Alloy Steels, Dead- and Live-Loads, Impact Loads, First Principles of Designing, Shop Work, Elevated Railroads, Cantilever Bridges, etc. A large number of tables taken from the author's office practice are included. There are also several chapters on Foundations, Piers, etc.

The two volumes comprise a vast amount of material brought together for practical information. At the end of the second volume is a comprehensive glossary of technical terms as they occur in bridge engineering, and a rather too scanty index. The book would have been more convenient for reference if a complete table of contents and index had been given in each volume so that any particular subject could more easily be found.

Its use for reference would have been facilitated also by subdividing the chapters into numbered articles or paragraphs with their particular titles printed in heavier type. These headings might also be placed at the top of the page instead of the senseless repetition of the general title of the book on every other page. This is a defect of makeup which is quite general in technical books and for which the printers are largely to blame. In the present work there are whole chapters without a single subhead, so that the finding of any desired subject is made unnecessarily troublesome and time-consuming. This is further aggravated by the manner of reference to articles published elsewhere, by number of volume of periodical or journal instead of by date of publication, a sort of pedantry found also in the transactions and journals of engineering and other scientific societies.

The book is profusely illustrated, but the selection of the subjects is not always fortunate. Some of the line drawings are rather elementary, and many of the views are of little value. A few more good typical detail drawings, representative of best modern practice, would have been more instructive.

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The book is too large to have its character and scope adequately discussed in any brief review. It appears to be valuable and authoritative only in so far as it deals with the engineering of bridges of ordinary span and type, that have already become more or less standardized. When the author ventures outside of this field into the domain of long-span and indeterminate structures, his insufficiency of knowledge and experience are betrayed (pp. 217, 272, 474, 482, 586, 594, 621, etc.), and his lack of grasp of the big questions in this field becomes evident. This may sound like harsh criticism, but it appears justified in view of some of the author's pretentious but erroneous judgments on higher-class structures.

Prejudices and Mannerisms

In this work, as well as in its forerunner, "De Pontibus," the author's attitude toward the general question of using indeterminate structures is one of unfounded prejudice, which may find too readily believers among novices in bridge engineering. He goes too far when he presumes to represent in this respect the best opinion of American bridge engineers. There may have been some justification for the avoidance of such structures in the early days before the theories for their design had been developed, but in the present day of advanced structural theory the prejudice has no justification. The greater amount of labor in the computations cannot be admitted as an objection in large and costly structures, when there is a gain in stiffness and economy, as well as in æsthetics. The legitimacy of these types denounced by the author should be considered past discussion among bridge engineers.

On certain other peculiarities of the work, the author himself touches in his preface, as when he mentions the characteristically personal style of his writing. He explains this by stating that "the book is intended to be, in a certain sense, a record of the author's life work, prepared after a ripe experience"; and he trusts that it will win the recognition of his fellow engineers, so they may find him worthy of that famous Colorado epitaph: "He done his level damnedest; no angel could do no more." The reader can hardly escape the impression that, true to this aim, the author tries his level best throughout both volumes not to hide his light under a bushel and to always first inform the reader of his own personal preferences and opinions (which, it is evident, he considers, though others may not, of leading importance) on the thousand and one questions that occur in the designing, laying out, contracting, fabrication, erection and maintenance of bridge structures.

While the breezy and often gossipy narrative form of presentation in many places may have merit for attracting the attention of inexperienced readers to an otherwise dry subject, it can hardly be recommended for imitation, as it swells the bulk of the reading matter far beyond what is necessary to give the really essential and valuable information.

It would have been more fortunate and in better taste, had the author omitted the bestowing of various degrees of eminence, excellence, notableness, leadership, etc., upon engineers, most of them still living. This glorification does not appear consistent with some of the criticisms that the author passes in other parts of the book upon the methods and work of the same engineers, although then they are not named. The text is also marred by an affected, though innocuous, punctiliousness in attaching to names inconsequential titles, as Esquire, C. E., member of, etc., as if marking some for social or professional distinction while others, not less distinguished, go without it.

Along with these mannerisms, the style lacks uniformity. Some chapters are examples of restrained and concise reasoning on a high plane, while others are written in an assertive and self-complacent jargon quite unusual in scientific literature. The difference in style and presentation is probably explained by the fact that parts of the book were prepared by different assistants, to whose helpful labor the author gives proper credit in the preface. It may also explain the lack of balance and proportion between the fullness of treatment of different topics in the book.

A considerable amount of trivial matter could have been omitted without detriment to the work. Thus (p. 1385), the author explains in elaborate detail the use of an erasing shield for making changes on drawings; this seems out of place in a book on bridge engineering.

Busy engineers, as a rule, prefer specific data and information in more condensed and matter-of-fact form in order that it may be more convenient for reference when a number of authorities have to be consulted. The judgment and views of other experienced engineers will probably not always agree with those of the author, as he himself anticipates. His reference to some bridge structures, designed by engineers not less able than the author, as hybrid, archaic or unscientific, betrays, perhaps unwittingly, an assumption of superiority for which there is no apparent warrant.

A Book of High Intrinsic Merit

These peculiarities of the so-called personal style are mentioned merely to indicate the undesirableness of vanities in engineering literature; it is done in the kindest spirit and with high personal regard for the author. Nor should the foregoing remarks be taken as deprecating the high intrinsic merit of the book as a whole, for it must be acknowledged to be an important contribution to bridge-engineering literature.

Among the special features of the work is the chapter on Alloy Steels, particularly nickel steel, for bridge construction. On this subject, of great interest to bridge engineers, the author has had special opportunities of investigation, although he has not had an opportunity to build a structure of any alloy steel himself. The author's paper on Alloy Steels, contributed to the International Engineering Congress at San Francisco in 1914, is here incorporated with additional information since collected. The intimation in one place that nickel steel was used in bridges only after his experiments had been made is not quite correct. Nickel steel was used in the Queensboro Bridge before the author's experiments with nickel steel were made known.

The suggestion, that alloy steels, if cheap enough, should also be used for short and for ordinary lengths of span, can hardly be indorsed. The greater unit stresses, which go with alloy steels, produce greater deflections and vibrations, hence less rigid and poorer structures, than with the usual structural steel. Alloy steels are justified only for long and heavy spans, and then only when not more expensive than those of structural steel. It is a good rule to follow, that of several designs of equal strength that bridge is the best which has the largest bulk and weight for the same money. A bridge

of structural steel at the same cost as of alloy steel is thus preferable, because stiffer and promising greater durability.

In Chapter VI, on Live-Loads, the author's computation of live-loads for railroad bridges is carried up to the E70 loading, which he considers as closely approaching the practicable limit for locomotives. He also mentions that in a recent design this limit has already been considerably exceeded, going up to the E90 limit for locomotives, but with the lower impact and higher unit stresses allowed, this loading is not more severe than an E60 loading with the usual impact and unit stresses. Heavy coal cars that, when fully loaded, exceed 7,000 lb. per lin.ft. and have axle loads of 64,000 lb. will, however, soon come into use on one of the eastern trunk lines.

American Impact Practice

In Chapter VII, on Impact, the author gives the history of the American practice and the various empirical formulas, including his own, used for railway spans of ordinary length with the usual open tie floor; also the modifications for highway bridges. He cites the few but as yet inconclusive experiments on bridge impact so far made. Professor Robinson's theory of maximum impact based on the coincidence of impulse from unbalanced drivers at certain speeds with period of vibration is elaborated. Formulas that take account of the important minimizing effect of dead-load upon impact, such as have been used in important heavy structures like the Beaver Bridge over the Ohio River or in the Hell Gate Bridge over the East River, or as contained in the bridge specifications of the Pennsylvania R.R., are not mentioned. Lindenthal's formula on bridge impact, which he deduced from observed facts and which is applicable alike to steel and masonry bridges of any length of span up to the longest, is not given. The author mentions Lindenthal's article on that formula in *Engineering News* of Aug. 1, 1912, but in his comments uses a quotation which, separated from its context, is entirely misleading.

The method of providing for impact by halving for live-load the unit stresses for dead-load is mentioned in another chapter (on Intensities of Working Stresses) and there properly condemned as an irrational practice, notwithstanding its continued use by some bridge engineers.

The subject of secondary stresses is very fully explained. In the chapter on Intensities of Working Stresses the author convincingly discusses the great and unnecessary variety of unit stresses obtaining in American practice.

Two of the best chapters are those on First Principles of Designing (XV) and Detailing (XVI). These are very comprehensive, including with well-known elementary matter the more refined newer methods of detailing.

Especially good also are the chapters on Floors and Floor Systems, Laterals, Sway-Bracing, Plate-Girder and Rolled I-Beam Bridges, Trestles, Viaducts and Elevated Railroads, Erection and Falsework.

The chapter on Deflections includes a lucid account of the Williot-Mohr graphical method of determining truss deflections.

The chapter on Simple Truss Bridges treats of the various kinds and forms of trusses, and the finesse of their design and detailing is fully elaborated. Yet the author's reasoning on the economy or wastefulness of certain truss types is not always convincing, nor supported by facts as judged by other practitioners. Too much is made of trivial economies of metal between one type and another, and of the danger from secondary stresses on mere theoretical grounds. Multiple-intersection trusses and the small-mesh lattice trusses are not as bad as painted by the author. The slight ambiguity in the web stresses and the secondary stresses at the intersection of the web members are of little practical importance when compared with the advantage of dividing up large web stresses among a greater number of web members, which at their intersections are connected and strongly bracing each other. Mere theoretical prejudice is keeping this rigid and cheaply manufactured type from more frequent use in riveted heavier and longer span trusses. The fact cannot be gainsaid that they have proved themselves very durable, and many of them over 40 years old are safely carrying loads twice as large as those for which they were designed. The author admits that very few bridges of the small-mesh riveted type have collapsed when derailed cars ran into end posts or into the middle of the web, as the theoretically immaculate truss with single web system invariably does.

Years ago it was the fashion to laud the virtues of the American pin-connected type as against the riveted European type. An engineer not falling in with the procession was tabooed. Nevertheless, the general wabbliness of the pin-connected truss bridge has led to its gradual abandonment even on longer spans. On the other hand, it needs to be pointed out that the American eye-bar and pin connections are eminently fitted for use in heavy structures of the lenticular and parabolic types, which are condemned without any good reason by the author.

For heavy or long spans crossing over railroad tracks or steamboat channels, where it would be a great advantage to have the bottom chord high above the floor as a protection against the corroding smoke underneath, the lenticular type is specially well suited. In this type the floor system is independent of the trusses and is not affected by the stresses in the bottom chord. Moreover, the wind truss in the plane of the floor can be provided with independent chords, and it can have a much greater width than the distance between the trusses, which offers an important advantage in long spans. The lenticular truss is one of the most accessible forms for painting and maintenance, and its supposed higher cost over the standard form of truss with curved top chord is a mere myth. The above is mentioned merely to illustrate how opinions of bridge designers on the merit of different plans may legitimately differ, and to emphasize the fact that dogmatic views are out of place.

Cantilever Bridges

In the chapter on Cantilever Bridges the subject is very extensively discussed, with numerous tables intended to be helpful in the laying out of designs. The author assumes, correctly, that this type is commendable only for long spans. Different forms of cantilever bridges are discussed and their merits and demerits analyzed from the author's point of view, which is not free from some of the prejudices held by less informed engineers.

It is a narrow view which holds that the great Forth Bridge could have been better designed with pin connections and by American engineers. They had the chance at the Quebec Bridge, and what a mess they made of

it! The gigantic structure in Scotland was built without a precedent to go by, and it was completed without a collapse or catastrophe such as marked the Quebec project. The Forth Bridge was required by the authorities to be dimensioned for the enormous wind pressure of 56 lb. per sq.ft., nearly double that assumed in American practice, and this added greatly to its weight. The structure is very rigid under trains at 60 mi. per hr., and considering the given abnormal conditions of dimensioning, erection and fabrication, it is a fine example of economic design with well-worked out details. A personal inspection of the bridge is convincing to any engineer who can appreciate the difficult problems in a long-span bridge of this type, that these problems had been skillfully solved.

As regards rules for length of suspended span, which the author discusses extensively, a variation of conditions not always in the control of the engineer will give different results from those advised by the author.

The great defect of cantilever bridges, unless heavy and of very long span, is their jerky vibration, especially disagreeable under highway traffic. This can be largely obviated by leaving out the suspended span and providing for a middle hinge. Such arrangement will prevent the vibrations from becoming cumulative, as is proved by the freedom from vibration of the Mirabeau Bridge in Paris (which is a shallow arch cantilever) and of the Queensboro Bridge (also named the Blackwell's Island Bridge) over the East River in New York, bungled as it is by gross errors and changes during construction.

Both types are statically determinate for dead-load and require no extra metal for erection stresses. The stresses from live-load, which are smaller than those from dead-load, are the only ones that require computations based upon the laws of elasticity of the metal. The methods for these have been so perfected, as already mentioned, that the same degree of accuracy can be obtained by careful designers as in the statically determinate types. Only the labor of computation is greater, but that labor is what the engineer and computer are for. To make the work easier for himself is a poor reason for an engineer to advocate and choose a shaky type for a bridge.

The Queensboro Bridge

The author indulges in certain witticisms on the Queensboro Bridge, but these are equally applicable to numerous other bridges. There are few structures, even of those designed by the author, about which some amusing things could not be written, but such do not furnish instruction to engineers.

The selection of the type for the Queensboro Bridge was thoroughly justified on structural and æsthetic grounds, which will be recognized by advanced designers when they know the reasons for the selection.

Several erroneous impressions about this structure have found currency among engineers and are incorporated in the author's book, which need correction. The type selected has nothing to do with the present weakness of the bridge, as the author asserts. That would have happened with any type whatever. The trouble was brought about by a change of city administration and a consequent change in the engineering direction of the work. That structure is a monument to the vicious system of frequent political changes in the administration of our public works. In this system engineers are as often abettors as victims.

In the case of the Queensboro Bridge the plans for the superstructure were changed after the contract had been let. The reasons and the manner of that change will not bear daylight. Not only were errors committed in dimensioning through irresponsible changes, but the detailing of the trusses and bracing is clumsy, as though designed by blacksmiths rather than engineers. The author's effort to ascribe the bungling and bad work in that bridge to the omission of suspended spans (p. 586), and his echoing of extravagant statements of the waste of millions of money in sole consequence thereof, are not creditable to his perspicacity. His credulity could not have been imposed upon to that extent, if he had a better acquaintance with designs of the statically indeterminate order for long spans.

Lack of Correct Information

The author's neglect to get correct information is further shown by this criticism of ties to carry the web forces to the top of the tower posts (p. 594) instead of using inclined end posts for carrying them directly to bearings on the piers. The distance between the truss planes is less than the distance between the tower bearings on the piers. The existing tower posts spread out to the bearings and are outside the planes of the trusses, as any visitor to the bridge can see. Inclined end posts in the plane of the trusses would therefore have rested on the masonry arch between tower bearings, a dangerous arrangement. For that reason the web forces are carried through inclined ties to the tops of the towers.

Moreover, the expedient left, on each side of the tower post, room for passageways from the roadway to wagon elevators to be placed in stone towers to be attached to both ends of the island piers and forming an important part of the stone architecture of these piers. These elevator towers were also contracted for and work thereon commenced. But the contract for them was canceled by a stupid, if not corrupt, administration, so that Blackwell's Island is left to this day without the urgently needed connection with the bridge.

The chapter on Arch Bridges is not so full as that on Cantilever Bridges, and it is evident that the author flounders here in deep water. He brings forth some very curious statements. On p. 621, for example, the author, admitting his total lack of experience in this field of design, nevertheless asserts, without any foundation and "upon general principles only," his belief and confidence that hingeless arches are less economical than the three-hinged type. He

> feels quite confident that if he should ever figure one, he would find that a proper provision for excessive temperature stresses, possible large indeterminate stresses, unusual detailing, heavy anchor bolts and an inherent sense of fitness in proportioning sections would so increase the weight of metal as to absorb all of the theoretical economy over the three-hinged arch involved by the average direct stresses as shown on the stress sheets. Were it not for the immense amount of labor required and for the lack of time at his disposal for the finishing of the manuscript of this book, the author would settle this question finally by making several complete detailed designs and computing the resulting total weights of metal. A correct comparison could be obtained in no other way—moreover, it would have to be made by an expert bridge designer, who would know how to care properly for all the unusual stresses and conditions.

The author really seems to believe that the engineering profession is waiting for him to acquaint himself with the theory of these types, so that he may do the "figuring" and show up the ignorance of all previous investigators in this field! It would be difficult to find in engineering

literature a parallel to this; it may be entertaining, but it certainly is not instructive.

The chapter on Suspension Bridges, with which the author confessedly has had less experience than with other types, is still shorter than that on Arch Bridges. It would have been worth while, however, to point out the existence in this country of very satisfactory examples of rigid suspension bridges aside from the heavy structures of long span over the East River. Among these are the stiffened chain bridges in St. Louis and (Point Bridge) Pittsburgh, the stiffened wire-cable bridges over the Ohio River at East Liverpool, Ohio, and at Parkersburg, W. Va., and the Cincinnati Suspension Bridge (although this latter is not a good type), all carrying heavy electric cars. The Ohio suspension bridges, of about 700- to 800-ft. span, are much stiffer and also much cheaper than equivalent cantilever bridges.

These and other examples of stiffened suspension bridges prove that the author's statement (p. 569) that "compared with a suspension bridge, a cantilever bridge is rigidity itself" is not based on fact, and that a rigid suspension bridge of rational design can very well compete with the cantilever system for length of span much below 1,600 ft., the limit which theoreticians on insufficient data have assigned. This applies to railroad as well as to highway bridges.

Safety of Suspension Bridges

The absolute greater safety and dependableness of the suspension type may be recognized from the example of the old Brooklyn Suspension Bridge. This bridge, as is well known, has very inadequate stiffening, yet is remarkably free from noticeable vibration. It is notoriously overloaded every day (that is, the moving loads on it are much greater, sometimes by 100%, than anticipated in the original plans), yet the bridge is safe and stiff under a traffic that is denser than on any other existing bridge. It is like a basket; it cannot collapse. A cantilever bridge from the same overloading would be highly unsafe. The failure of a single overstressed truss member would bring the structure down, as in the Quebec Bridge. These qualities are not disclosed by strain sheets; a rational comparison of the two types cannot be made that way.

For the longest feasible bridge spans all engineers have now long agreed that the suspension type is the only practicable one. But such bridges will be very few, and for their best design the engineer will need more searching studies than the author's book can afford.

The subject of Movable, Swinging and Bascule Bridges is fully treated in a descriptive manner. A more detailed treatment of the subject is promised to come later from Mr. Harrington, Mr. Waddell's former partner.

The chapters on Riveted vs. Pin-Connected Trusses, on Camber, on Protection of Metal Work against Rusting, will be found by the reader to be full of useful instruction.

The chapter on Reinforced-Concrete Bridges sets forth the precautions and methods to be observed with this brittle and variable material, for which, however, any calculations based upon elastic properties should always be made with a large margin of safety.

Welcome information to most railroad engineers will be the sections on the United States Laws for Bridges over Navigable Waters, the rules governing applications to the War Department for permission to bridge navigable waters, the preparation of drawings to submit to the authorities, etc.

Chapter LII treats of Aesthetics in Design, a subject which the author seems to have particularly at heart. But one cannot say that his taste will always be shared by other designers. *De gustibus non est disputandum.*

This is illustrated (p. 1178) in the author's plans for two bridges over the Danube at Budapest, submitted in an international competition for prizes in 1894, in which architectural merit was to be determining.

The Hungarian engineers, than whom more cultured ones are rarely met, must have wondered not a little that anybody could seriously propose trusses of the ordinary stock design with curved top chords stretched out to spans of over 1,000 ft. as works of art and as fit neighbors to Tierney Clarke's famous chain suspension bridge of classic beauty. Many readers will marvel also at the strange-looking ornaments planted at the ends of the spans in the author's designs, and their wonder will grow when they read his complacent statement that he publishes these views to show his conception of the proper artistic design of bridge approaches.

The author's criticism on the architecture of the Tower Bridge in London, with a quotation from the writings of H. Heathcote Statham, is not shared by educated architects. To many, the ensemble and articulation of the structure appear striking and picturesque and in harmony with the historic surroundings and background of the old tower group architecture, though some of the details may be objectionable.

The author's repeated reference to æsthetic appearances based on nothing more than curves in the top or bottom chords will appear to others rather naïve. This chapter on architecture is well meant as an earnest plea to bridge engineers to show themselves in their work as cultured men. The author, however, in undertaking to furnish instruction and guidance to seekers of the æsthetic in bridge construction, has set himself a task that is evidently beyond his scope. For any bridge structure requiring architectural consideration the bridge engineer will do well to consult a competent architect; and experience has shown that not every architect is competent here.

The next two chapters, on Economy in Design and Determination of Layouts, very ably discuss the conditions of true expertness in designing. The following chapter, on Weights of Steel Superstructures, is among the best in the book. A very instructive and useful chapter is the one on Business Features of Bridge Engineering. The sage advice given therein by the author is well worth heeding.

As already stated, it is impossible in a mere review to more than hint at the contents, peculiarities and merit of the two volumes on "Bridge Engineering" produced by Dr. Waddell. Notwithstanding the idiosyncrasies that it has seemed needful and proper to point out, too much credit and praise cannot be given the author for his assiduous labor of many years, which the preparation and compilation of the immense amount of material for his book involved. Financial profit there will be none, rather a loss, as is well known to engineers who have tried to write books at their own expense. The compensation to the author will be the satisfaction of having contributed his share to the progress of bridge engineering, and a most valuable share it is, for which the grateful appreciation of his fellow engineers is due him.

Railway Passenger Terminals

PASSENGER TERMINALS AND TRAINS—By John A. Droege, General Superintendent, New York, New Haven & Hartford R.R. New York: McGraw-Hill Book Co. Cloth: 6x9 in.; pp. v + 410; 220 illustrations. $5.

A book on the principles and practice involved in the design and operation of railway passenger terminals has long been needed, and Mr. Droege's work is a valuable addition to railway and engineering literature. It is comprehensive and systematic in scope, covering the design or planning of terminal layouts, the design of station buildings, the facilities requisite for train and station service, and the operation of trains and general station traffic. It shows clearly the need of active cooperation between different departments and officials in order to secure results satisfactory to the railways and the public.

The book opens with a review of the high degree of service rendered in the passenger traffic of American railways as compared with those of other countries. It points out also that this results in the very undesirable condition that passenger traffic as a whole is not profitable to our railways.

As to the terminal stations themselves, the too-frequent unsatisfactory architectural design is noted, and interesting comparison is made between the very large area of waiting-room space provided in American stations and the relatively small area in European stations. Thus while two modern American stations provide 25,000 and 33,000 sq.ft. for this purpose, one of the largest stations in London (handling much greater traffic than either of the others mentioned) provides only 3,000 sq.ft.

It could be wished that the details of individual terminals had been treated somewhat more critically (instead of being mainly descriptive). One real omission is that there is no general discussion of the principles and requirements in station planning, although different phases of the subject are dealt with in regard to individual stations. Nor is there any reference to the methods and diagrams employed in determining the traffic capacity of terminals. This matter has been discussed somewhat fully in reports of the yards and terminals committee of the American Railway Engineering Association.

The consideration of terminal layouts includes through or side stations, stub or headhouse stations, waterfront terminals, and the passenger terminals of New York, while one chapter deals with trains and terminals of foreign countries. Approaches, interlocking and electrification are dealt with, from both the engineering and operating points of view. The chapter on small stations is interesting, though a little foreign to the main subject of the book, and incidentally it discusses the different methods of operating trains and locating way stations on four-track lines.

Platforms and trainsheds are important features. The old style of long-span arched trainshed is obsolete, preference being given to the Bush type of low multiple-span trainshed or to individual platform shelters. No reference is made, however, to the trainshed design in which the columns are placed between the tracks instead of upon the platforms, the latter practice being almost universal. It is singular that the author classes the platform shelter as a type of trainshed, though the two are essentially different.

Station design must include adequate facilities in the way of waiting, rest, dining and lunch rooms, ticket and baggage offices, hospital and immigrant rooms, and the numerous conveniences required to meet the conditions of modern service. Some of the various other subjects covered are the illumination of platforms and stations, the use of stairs and inclines, handling mail by belt conveyors and baggage by small motor trucks and inclined elevators, the removal of snow in terminal yards, the provision of train bulletin boards and announcers, and the methods of communicating between the dispatcher (or signal tower) and the crews of trains in the station.

Subjects of particular interest to the operating official are trackage and terminal agreements, passenger terminal operation and train operation, the station master, the ticket office and baggage room, car cleaning, and timetables and train schedules. Supplementary matters dealt with include accidents, the commissary department, and statistics of passenger service. The numerous illustrations include terminal plans and a variety of halftone engravings.

Written by a man of long experience in railway service, this book is of distinct and practical value to the engineer, the architect, the operating official and the student of railway affairs and problems. The engineer finds grouped here matters relating to the general layout and design of terminals. The architect will find numerous points of importance in regard to the interior plan and facilities of the buildings, points which none but a "railway man" would think of or suggest. For the operating official there is a wealth of information on matters important in general and in detail. A notable feature of the book is the interesting and readable style in which it is written. It is a worthy companion to the author's earlier book on "Freight Terminals and Trains."

Bitumen Analyses and Tests

REVIEWED BY J. E. MYERS*

LABORATORY MANUAL OF BITUMINOUS MATERIALS—For the Use of Students in Highway Engineering—By Prévost Hubbard, Assoc., Am. Soc. C. E.; Chemical Engineer; Chief, Division of Road Material Tests and Research, Office of Public Roads and Rural Engineering, United States Department of Agriculture. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xi + 153; 7 tables and 39 illustrations. $1.50 net.

The author states that this manual is intended "as a laboratory guide for students of highway engineering and not as a treatise on methods of analyses and tests of bituminous materials," also that the manual deals with "the interpretation of results of tests" and with "the identification, suitability for specific purposes and control of uniformity of materials tested."

The subject matter is divided into three parts: (1) Description of materials; (2) tests and methods; (3) application or results.

The description of the materials in Part I is so arranged as to place briefly before the student a working knowledge of the subject. Five general group headings are given: (1) "Fluid Petroleum Products and Emulsions"; (2) "Semi-Solid and Solid Petroleum and Asphalt Products"; (3) "Refined Tars and Tar Pitches"; (4) "Creosoting Oils"; (5) "Bituminous Aggregates." Under these headings may be grouped all bituminous road materials in common use.

In addition to the general group headings there is a detailed classification of the crude bituminous materials

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based on the source of the material. Following this classification is a brief description of the refining processes used to produce road materials from the crude bitumens. By arranging these refined products according to their use for surface treatment or for incorporation in the pavement structure, together with a brief description of the desirable characteristics of these materials and their method of application, the author covers the subject of bituminous materials and their place in road construction in a clear and concise manner.

In Part II is a description of those tests which have been adopted as standard, together with other tests which are in common use but have not as yet been accepted as standard. The author gives a detailed description of the methods of performing the tests and a brief explanation of the results or value of the test.

Since the book is written with the primary object of being a laboratory manual, it would seem that the author could well have devoted more space to detail in the description or manipulation of a number of the tests described. For instance, in the distillation test, the student is instructed to pour 100 c.c. into the distillation flask. This quantity must be measured exactly, since the results are to be reported by volume as well as by weight. The exact volume measurement of a given quantity of a viscous liquid presents a considerable problem for a student beginning the study of bitumens.

The author has also neglected to harmonize detail in a number of the methods described. In the distillation test already mentioned, two methods are given—the generally accepted method for the distillation of tars; and the method usually followed in the distillation of creosote oils. In the description of the apparatus to be employed the student is instructed to use a carbon-dioxide-filled thermometer in one case and a nitrogen-filled thermometer in the other.

The author has illustrated the practical value of testing bituminous road materials in Part III by giving the ordinary tests made on those materials which are in common use together with typical results obtained from these tests. These results are explained or interpreted, and the characteristics of the material as indicated by the tests are discussed with reference to the use of the material in road building.

Pocket-Book for Engineers

HANDBOOK OF FORMULAS AND TABLES FOR ENGINEERS—Compiled by Clarence A. Peirce, Assistant Professor in Power Engineering, with Mathematical Sections by Walter B. Carver, Assistant Professor of Mathematics, Cornell University. Second edition, revised and enlarged. New York: McGraw-Hill Book Co., Inc. Flexible leather; 4x7 in.; pp. xii + 188; illustrated. $1.50 net.

The first edition of this handy little compendium of mathematical notes and tables was favorably noticed on p. 264 of *Engineering News*, Feb. 11, 1915. In the present edition a small amount of material has been added, consisting mainly of a paragraph on the laws of exponents, the formulas of hydraulics, tables of natural logarithms and hyperbolic functions, a reproduction of the Ellenwood steam chart and a table of steam properties made up from the Marks and Davis tables. The authors point out that it was their original purpose to produce a small book of really convenient pocket size; and that inasmuch as excellent handbooks of larger size are available, they have felt it wise in producing this second edition to adhere to the policy of the first.

Contractors' Cost Keeping

PRACTICAL COST KEEPING FOR CONTRACTORS. A Book Giving a System of Accurate Cost Keeping and the Methods Used for Adapting It to All Classes of Construction Work—By Frank R. Walker, Author of "The Building Estimator's Reference Book." Chicago (30 North Michigan Ave.): The Author. Cloth; 4x7 in.; pp. 273; 15 illustrations. $2.

On different methods of cost keeping there are many opinions, but the practical necessity of keeping a record of costs will not be denied by more than one contractor in a hundred. It is not a simple task to prepare a *useful* book on this subject, because the various kinds of contractors' organizations make any one system inapplicable to more than a limited number of firms. The prime requisite in systems designed for contractors is simplicity. If the system is not simple, it is not workable. Mr. Walker in his book recognizes this principle on page 1 of Chapter 1. This in itself suggests that the book is worth reading by anyone seeking to inform himself on the subject.

The classes of construction considered chapter by chapter are numerous, as they need be, and include such operations as "Driving Piles," "Foundation Work," "Water and Damp Proofing," "Cement and Composition Floors and Base," "Hollow-Tile Fireproofing," "Roofing," "Painting and Varnishing" and the various classes of interior fitting.

The forms required to keep labor costs in Mr. Walker's system and those for recording material costs are given in separate chapters. The daily construction report is explained, and illustrations are given of Mr. Walker's conception of what such a report should embrace. In the back part of the book are given samples of estimate sheets, weekly progress reports, order blanks and requests-for-bid cards.

As the author says, while the average building contractor will not find use for all the forms submitted, he is given a fairly wide choice. It should be noted, too, that many contractors, with numerous and varied wants, are required to make up the average contractor, so forms not needed by some will be prized by others.

Oregon's Water Code Explained

CONTROL, DISTRIBUTION AND USE OF THE WATER RESOURCES OF OREGON, November, 1916: Rules, Regulations, Forms and Practice—Compiled under direction of John H. Lewis, State Engineer, by Percy A. Cupper, Assistant State Engineer. Salem, Ore.: Office of the State Engineer. Paper; 6x9 in.; pp. 70.

The Oregon Water Code, enacted by the State Legislature in 1909 to secure simplicity, directness and economy in recording water rights, both old and new, and in providing administrative machinery for proper distribution of water, has recently been upheld by the United States Supreme Court (as noted at length in *Engineering News*, June 29, 1916). This decision is of the greatest importance to the various states of the Union, as it establishes the legality of such boards of engineers and other experts and makes it possible for these bodies to plan their efforts comprehensively. Therefore this bulletin, giving detailed information about the administration of the Oregon Code, is of importance and interest. It fully describes the principles and procedure of initiating new water rights and of determining old rights. A third part, on distribution of water, describes the organization of water districts under water masters who oversee the taking of appropriated flow, inspect gates, prevent waste and regularly report on their districts' needs and supply. This section of the pamphlet describes the construction

ted use of trapezoidal weirs. A fourth section reviews court decisions on the Code, and an appendix shows the 27 forms for letters, certificates, notices, etc., mentioned in the body of the bulletin.

Mason's Water-Supply Revised

WATER-SUPPLY, Considered Principally from a Sanitary Standpoint—By William P. Mason, Professor of Chemistry, Rensselaer Polytechnic Institute; M. Am. Soc. C. E. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. x + 528; illustrated. $3.75 net.

By omission, revision and the addition of uptodate matter Professor Mason has enlarged his "Water-Supply" by 80 pages net. The plan and general character of the book have not been changed. It still deals chiefly with water, its natural fitness for human use and the ways of making unfit water more fit. In addition, there are chapters on per capita water consumption and the action of water on metals. The first edition, published 20 years ago, was noted in *Engineering News* of Oct. 1, 1896, p. 224, and the third edition, July 17, 1902, p. 52.

More on Activated Sludge

AMERICAN SEWERAGE PRACTICE: Vol. III, Disposal of Sewage—By Leonard Metcalf and Harrison P. Eddy. Second edition, with appendix on Activated Sludge and minor revisions. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xv + 877; 234 illustrations and 190 tables. $6.

The authors of this book are to be congratulated for an opportunity to revise and extend it within a year of first publication. Aside from slight revisions the body of the volume remains unchanged, but the 12-page account of activated sludge in the first edition has now been extended and brought well down through 1916 by an appendix of 25 pages. The first edition was favorably reviewed, as it deserved to be, by John H. Gregory in *Engineering News* of Dec. 16, 1915, p. 1168.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ACCURACY OF STEAM-FLOW DATA—By N. C. Grover and J. C. Hoyt. Washington, D. C.: United States Geological Survey. Water-Supply Paper 400-D. Contributions to the Hydrology of the United States, 1916. Paper; 6x9 in.; pp. 53-59.

ALTERNATING CURRENTS—By Carl Edward Magnusson, M. S., Ph. D., E. E., Professor of Electrical Engineering, University of Washington; Fellow, Am. Inst. E. E. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xv + 525; 475 illustrations. $4 net.

THE AMERICAN CITY: An Outline of Its Development and Functions—By Henry C. Wright, First Deputy Commissioner, Department of Public Charities, New York City. New York: A. C. McClurg & Co. Cloth; 4x7 in.; pp. 178. 50c. net.

AMERICAN RAILWAY ENGINEERING ASSOCIATION: Proceedings, 1916 Convention. Chicago, Ill.: The Association. Cloth; 6x9 in.; pp. 1391; illustrated. $5.

ANATOMY OF A STEEL HOPPER-BOTTOM COAL CAR—By George L. Fowler. New York: Norman W. Henley Publishing Co. Broadside; 24x18 in. 25c.

Isometric view and details, with printed list of parts.

CITY RESIDENTIAL LAND DEVELOPMENT: Competitive Plans for Subdividing a Typical Quarter-Section of Land in the Outskirts of Chicago—Edited by Alfred B. Yeomans, Landscape Architect. Chicago, Ill.: University of Chicago Press. Cloth; 9x12 in.; pp. 138; illustrated. $3 net; postage extra; weight, 3 lb.

COST ACCOUNTING AND BURDEN APPLICATION—By Clinton H. Scovell, C. P. A., Assoc. Am. Soc. M. E. New York: D. Appleton & Co. Cloth; 6x8 in.; pp. xiv + 328. $2 net.

THE ELEMENTS OF REFRIGERATION: A Textbook for Students, Engineers and Warehousemen—By Arthur M. Greene, Jr., Professor of Mechanical Engineering, Russell Sage Foundation, Rensselaer Polytechnic Institute. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. vi + 472; 192 illustrations. $4 net.

ENGINEERING CHEMISTRY: A Manual of Qualitative Chemical Analysis for the Use of Students, Chemists and Engineers. By Thomas B. Stillman, M. Sc., Ph. D., Member, American Electro-Chemical Society. Easton, Penn.: Chemical Publishing Co. Cloth; 6x9 in.; pp. viii + 260; 150 illustrations. $5.

ENGINEERING OF POWER PLANTS—By Robert H. Fernald, M. E., A. M., Ph. D., Whitney Professor of Dynamical Engineering, University of Pennsylvania, and George A. Orrok, M. E., Consulting Engineer, New York. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. ix + 586; 309 illustrations. $4 net.

FLOODS IN THE EAST GULF AND SOUTH ATLANTIC STATES, JULY, 1916. By Alfred J. Henry. Reprinted from Monthly Weather Review, August, 1916. Washington, D. C.: United States Department of Agriculture. Paper; 10x12 in.

An abstract of this interesting and valuable report appeared in "Engineering News" for Nov. 9, 1916, p. 886.

FLOW OF WATER UNDER PRESSURE THROUGH CLEAN CLOSED PIPES: Tabulated Data with Explanatory Notes—By George T. Prince, C. E., M. Am. Soc. C. E. New York: D. Van Nostrand Co. Cloth; 4x7 in.; pp. v + 149; illustrated. $2.

GENERAL PHYSICS: An Elementary Treatise on Natural Philosophy—By William S. Franklin and Barry MacNutt. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. viii + 604; 479 illustrations. $2.75 net.

GUIDA PRACTICA DEL MECCANICO MODERNO—By A. Massenz. Milano: Ulrico Hoepli, editore. Cloth; 4x6 in.; p. xxiv + 351; 331 illustrations. L. 4.50.

HANDBOOK FOR MACHINE DESIGNERS, SHOPMEN AND DRAFTSMEN—By Frederick A. Halsey, B. M. E., M. Am. Soc. M. E. New York: McGraw-Hill Book Co., Inc. Second edition. Cloth; 9x11 in.; pp. xii + 561; illustrated. $5 net.

HOW OTHER CITIES IN THE UNITED STATES ARE DISPOSING OF THEIR SEWAGE: An Investigation Made for the Cities of Pasadena, South Pasadena and Alhambra, in May and June, 1916—By T. D. Allin, Commissioner of Public Works and R. V. Orbison, City Engineer, Pasadena, Calif. Paper; 6x9 in.; pp. 8.

A LABORATORY COURSE OF PRACTICAL ELECTRICITY for Vocational Schools and Shop Classes—By Maurice J. Archbold, Instructor in Vocational Electricity, Wendell Phillips High School, Chicago, Ill. New York: The Macmillan Co. Paper; 8x10 in.; pp. ix + 222; illustrated. $1.10.

LUBRICATING ENGINEERS' HANDBOOK: A Reference Book of Data, Tables and General Information for the Use of Lubricating Engineers, Oil Salesmen, Operating Engineers, Mill and Power-Plant Superintendents and Machinery Designers—By John Rome Battle, B. S. in M. E. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 6x9 in.; pp. 333; 114 illustrations. $4 net.

MEDIATION, INVESTIGATION AND ARBITRATION IN INDUSTRIAL DISPUTES—By George E. Barnett, Ph. D., Professor of Statistics, Johns Hopkins University, and David A. McCabe, Ph. D., Assistant Professor of Economics, Princeton University. New York: D. Appleton Co. Cloth; 5x8 in.; pp. viii + 209. $1.25.

MUNICIPAL ENGINEERING PRACTICE—By A. Prescott Folwell. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xi + 422; 113 illustrations. $3.50 net.

NATIONAL ELECTRICAL SAFETY CODE: for Examination, Trial and Constructive Criticism. Second edition. Washington, D. C.: Bureau of Standards. Paper; 7x10 in.; pp. 323; illustrated. 40c. per copy from Superintendent of Documents.

NEW YORK STATE COMMISSIONER OF HIGHWAYS: State of New York Report—Albany, N. Y. Cloth; 6x9 in.; pp. 939; illustrations.

RAILWAY TRACK ECONOMICS: A Tabloid Treatise Upon Railroad Problems—By August G. Liebmann. Chicago, Ill.: The Author (7433 Emerald Ave.) Leather; 5x9 in.; pp. 66. $3.

The main purpose of this book is to advocate the use of the European type of chairs for supporting track rails. This is done in a few words at the end of many pages of miscellaneous notes on railway finance, traffic, equipment and track. No description of the proposed construction is given.

SURFACE WATERS OF MASSACHUSETTS—By C. H. Pierce and H. J. Dean. Washington, D. C.: United States Geological Survey. Water-Supply Paper 415. Paper; 6x9 in.; pp. 433; illustrated. 45c. a copy from Superintendent of Documents.

TEMPERA E CEMENTAZIONE DELL' ACCIAIO—By Mario Levi-Malvana. Milano: Ulrico Hoepli, editore. Cloth; 4x6 in.; pp. xii + 261; 66 illustrations. L. 4.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Vol. 8, 1915—New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. iii + 309; illustrated. $6.

TREATISE ON HYDRAULICS—By Mansfield Merriman, M. Am. Soc. C. E., with the assistance of Thaddeus Merriman, M. Am. Soc. C. E. Tenth edition, revised. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. x + 565; illustrated. $4 net.

WATER PENETRATION IN THE GUMBO SOILS OF THE BELLE FOURCHE RECLAMATION PROJECT—By O. R. Mathews, Assistant, Dry-Land Agriculture Investigations. Washington, D. C.: United States Department of Agriculture. Bulletin No. 447. Paper; 6x9 in.; pp. 12; illustrated. 5c. a copy from Superintendent of Documents.

WATER-SUPPLY COMMISSION OF PENNSYLVANIA: Report for 1915—Harrisburg, Penn. Cloth; 6x10 in.; pp. 403.

Notes from Field and Office

Steep chuting of concrete—Improvised dump car—Air chamber protects venturi meter from pulsations—Safe grade crossings in California—Steadying the suction pipe—Calculating four-sided areas

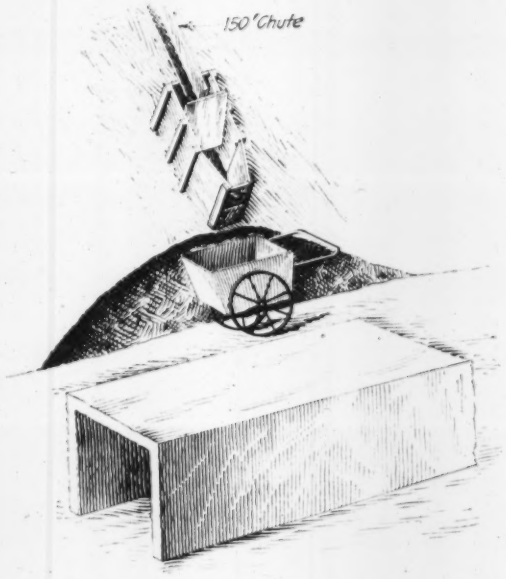
Chuting Concrete Down Steep Slopes from Mixer

Concreting methods on the bridges and culverts on the 50-mi. Southern Ry. relocation in Georgia and South Carolina vary from hand mixing and placing to placing by elaborate cableways. Two jobs of special interest that differ widely as regards their relative importance but agree in the general method of concrete placing are described herewith. One is a rather small (about 1x1 ft.) culvert about 2 mi. south of Toccoa, Ga.; the other is a double-track concrete bridge consisting of four 80-ft. arches. In both cases Smith mixers discharged into chutes laid down a steep slope.

The chuting arrangement from mixer to receiving hopper at the culvert site is shown in the view and sketch. The chute is about 150 ft. long and its half-dozen sections are strung together down a slope of about 45°. First of all the timber was cleared from the slope, for use in building the filling trestles, of which there are two as shown.

CHUTING ARRANGEMENT FOR BUILDING A SMALL CONCRETE CULVERT

Teams bring the concrete materials to the mixer at the top of the hill. The mixer discharges directly into the chute. Just below the receiving hopper the slope has been cut down by spade and flattened to the culvert forms, so that the concrete can easily be transported to the forms by a buggy, shown in the sketch.



SKETCH SHOWING MIXER CHUTE, RECEIVING HOPPER, BUGGY AND DUMPING TRESTLE

The new line of the railway will cross Coneross Creek in South Carolina on a concrete bridge now building alongside the existing truss bridge. Two concreting plants are employed, one on each side of the stream. The south bank is steep and the mixer is installed on the top, discharging into a chute running into one of the pier-foundation forms.

The other chuting outfit was installed some time later with bins under the old bridge, so that the work train could stop over the bins and discharge directly into them. Under the bins is a platform carrying the mixer, discharging into small cars, which are pushed by hand to the north abutment nearby. There the concrete is delivered into closed chutes.

In the first part of October concreting was starting at Pier 1 on the south side and at the north abutment. Water in the excavations was kept down by a centrifugal pump in the pier pit and pulsometer in the abutment excavation. In excavating, the soil was removed by dump buckets loaded by a gang of a half-dozen men in the pits.

The wood sheetpiling was put down by a piledriver, the lower line of sheeting being driven by maul. The bridge is being built by Hickey Bros., of St. Louis; J. O. Smith is assistant engineer in general charge of the work for the Southern Ry.

Safe Loads on Rope Slings

By F. W. Salmon*

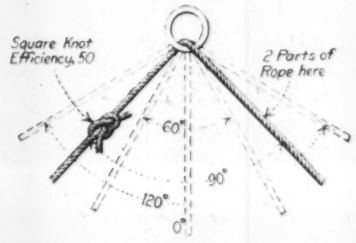
The attached condensed tables should prove very useful to engineers and contractors, particularly if they will cut them out and paste them in their notebooks.

By holding the diagram up at arms' length with the cut of the slings about in line with a sling in use, the approximate angle of the sling in use can be estimated, and the appropriate column used, to find the probable safe load on new, treated manila-rope 4-part slings.

Of course one will have to exercise judgment as to the present condition of the sling or tackle he may be using, and take a lighter load if the rope is old, worn, cut, or if the conditions of service make it necessary, as for example the damage that might result from an accident, wind, jerks, etc.

In using tackles the strength of the hooks should be considered as well as the rope, remembering that in hoisting, the hook of the upper block must carry the load on the lower block plus the rope pull plus the weight of the tackle; thus with a double and single ¾-in. tackle, the maximum load is given as 1,700 lb. on the rope, three parts at the lower single blocks; but the safe load on the hook of a single block (factor of safety 3) is only 1,320 lb. If the load is reduced in that proportion the result will be a pull in the hauling part of $\frac{1{,}320 \times 670}{1{,}320} = 500$ lb. Now $1{,}320 + 500 + 75 = 1{,}895$ lb. at the hook of the upper double block, which is not materially above the rope load given as 1,800 lb. Of course moving the hooks will somewhat increase their safe capacity.

*326 North 20th St., Birmingham, Ala.



Working Loads on new Manila Rope Looped Slings, Knotted, Gentle Lifting

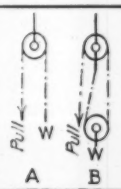
Rope Diameter Inches	Angle of Sling Opening			
	0	60	90	120
	Load in Lb. Avoird			
½	1,350	1,160	943	675
⅝	2,100	1,800	1,470	1,050
¾	3,040	2,610	2,125	1,520
⅞	4,120	3,540	2,880	2,060
1	5,400	4,630	3,780	2,700
1¼	6,830	5,870	4,770	3,420
1½	8,450	7,250	5,900	4,230

A short splice sling will carry 50% more

Sharp bends (such as the edge of a box) will reduce the safe load.
The table is for new rope of good quality not chafed, worn, cut or in any way injured, dry, carrying the load on 4 parts, all parts free to divide the load equally, made up with a square knot.

Strength of a rope with a knot in it to the strength of the body of new rope in % by careful tests made

Kind of Knot	%
Eye spliced over an iron thimble	90
Short splice	80
Timber hitch Round turn Half hitch	65
Bowline loop Slip knot Clove hitch	60
Square knot Weavers knot Sheet bend	50
Flemish loop Overhand knot	45



MANILA ROPE HOISTING TACKLE

Maximum loads for use in erecting under careful supervision, new dry rope, at slow speed, with commercially perfect blocks fair lead to all ropes, no chafing

FIG. E

Diam of manila rope In			½	⅝	¾	⅞	1	1¼	1½
Max pull lb. on hauling part			296	402	670	900	1,185	1,490	1,850
Fig.			Lb. lifted by tackle with above rope pull = W						
A	Number of parts of rope at the lower or moving block	1	272	370	615	828	1,080	1,370	1,700
B		2	553	752	1,250	1,680	2,210	2,790	3,460
C		3	750	1,020	1,700	2,280	3,000	3,780	4,700
D		4	955	1,300	2,170	2,910	3,840	4,820	5,980
E		5	1,130	1,535	2,560	3,440	4,530	5,700	7,070
Breaking load on 1 rope, lb.			1,775	2,770	4,000	5,440	7,100	8,930	11,100
Safe load on hook at ¼ breaking load of steel hook	Single block		738	990	1,320	1,800	2,125	4,570	5,430
	Double block		990	1,325	1,800	2,125	3,120	5,350	6,240
	Triple block		1,325	1,800	2,125	3,120	4,570	6,240	6,780
Size of block shell, inches			4	5	6	7	8	9	10

A 150-lb. man should be able to apply 75-lb. pull on rope at slow speed

DATA FOR DETERMINING SAFE LOADS ON HOISTING TACKLE

Range Finder and Clinometer

Maj. C. R. Young, of the Canadian School of Infantry, Toronto, Ont., has devised a simple instrument for roughly determining distances. It is based on the conclusion that it is easier to judge the size of familiar objects on the landscape than to judge their distance from the eye. With a little practice, it is claimed, an observer can make very close estimates of such dimensions as heights of buildings to the eaves, heights of common trees, telephone and telegraph poles, etc., while the heights of many things such as doors, cars, fences, horses and men are matters of common knowledge; and from these the ranges or distances are easily determined.

The instrument has been used successfully on military reconnoissance surveys and field sketching. The designer and Maj. H. H. Madill made extensive use of it in the plotting of a new 4-in. = 1 mi. maneuver map of Camp Borden. Apparently, it could be used with equal advantage in any reconnoissance survey work. The unit used on the instrument illustrated is the yard, but the same scales can be used for feet or inches if desired.

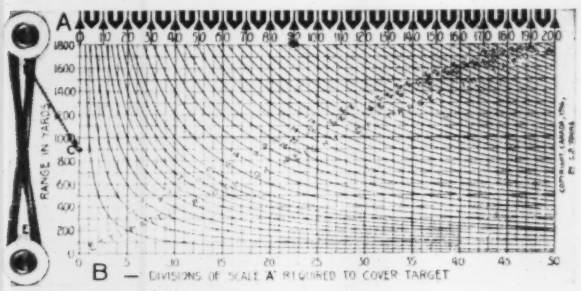
The accompanying illustration shows the instrument, which consists of a heavy, opaque piece of white celluloid 3x6 in. A small cord is attached to the card at C, on the left-hand border of the diagram. The length of the

cord is five times the length of the scale *A*, at the top of the card (about 25 in.) The rest of the card is nothing more nor less than a stadia diagram.

The end of the cord is held close to the eye, and the card is held at the other end of it in a perpendicular plane. The width or height of the target or object sighted at is read on scale *A*. Reading up from the same division on scale *B*, at the lower edge, to the curve of the corresponding reading, gives the distance or range to the nearest 100 yd., or feet, as the case may be, on the scale at the left.

If the reading on scale *A* exceeds the number of divisions shown on scale *B*, it is necessary to divide the reading by such a number as will give a quotient not greater than the maximum number of divisions on scale *B*. The range then found must be divided by the same number by which the scale *A* reading was divided.

The device may, of course, be used to estimate the dimension of a target or object at a known distance, and



RANGE-FINDING DIAGRAM, WHICH CAN BE USED IN TAKING TOPOGRAPHY

by putting the cord through the center hole in the top scale and attaching a weight or plumb bob it can be used as a clinometer. For this purpose the reverse side of the card carries a scale of angular divisions. The reverse side of the card also has directions for using the instrument and a table of dimensions of common objects.

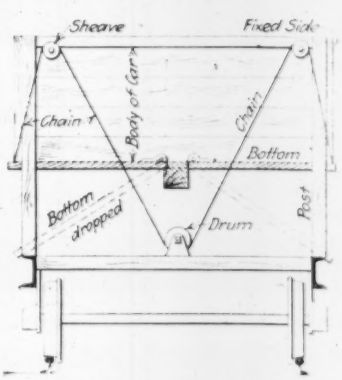
The device is copyrighted in Canada and may be obtained by engineers in the United States from Maj. C. R. Young, 98 Hilton Ave., Toronto, Ont., for 50c., postpaid.

Improvised Dump-Car

To handle the material from the foundation wells or caissons of the new Fox River bridge of the Chicago, Burlington & Quincy R.R. at Aurora, Ill., a special dump-car was rigged up on the work. As shown, it runs on a standard-gage track on a temporary filling trestle, and in loading position it stands under a hopper. The excavated material is hoisted in small buckets and emptied into skips; when these are full, they are raised and swung over the loading hopper by a derrick.

The car body is 6½x5 ft. and 30 in. deep, with a capacity of about 3 cu.yd. It is mounted on a frame of steel channels, with two axles and 18-in. wheels. The floor is set high and consists of two sections or leaves hinged along the center line and held up by chains attached to the outer side and wound upon a drum. To dump, the drum is released, and the floor sections fall to an inclined position, allowing the contents to slide off on both sides. The drum is then operated with a ratchet bar to wind up the cables and raise the floor sections to a horizontal position.

In operation the car forms part of an endless hauling system. A cable attached to one end is led direct to the drum of a hoisting engine; another cable leads from this engine to a snatchblock on a deadman at the end of the trestle, and back to the car. When full, the car is hauled out on the trestle, being ridden by a man who trips and closes the floor. The work is under the direction of W. Pringle, Assistant Engineer, Chicago, Burlington & Quincy R.R. The car was devised and built by R. E. Sheehan, foreman of the work on the bridge, which is being built by the railway company's forces.

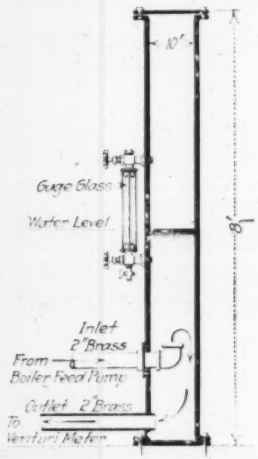


IMPROVISED DROP-BOTTOM DUMP CAR

Air Chamber Protects Venturi Meter from Pulsations

By A. O. Doane*

The accuracy of venturi meters is unfavorably affected by pulsations in the fluid passing through the meter tube. This trouble is easily remedied by placing an air chamber of proper design between the source of the pulsations and the meter tube. At the Chestnut Hill pumping station of the Metropolitan Water-Works of Massachusetts the feed water for one battery of boilers is pumped by a single-acting feed pump, the plunger of which is 2½ in. in diameter and is attached to the crosshead of the pumping engine which has a 60-in. stroke. At full speed the pumping engine makes 24 r.p.m. A small air chamber was connected to the pump, but this did not prevent very violent variations of pressure in the boiler-feed pipe line. This condition was very unfavorable for the satisfactory operation of a venturi meter which it was desired to install.



AIR CHAMBER FOR VENTURI METER

A special air chamber, designed in the engineering department and constructed by the pumping-station employees, proved entirely successful in reducing the pulsations, so that the accuracy of the meter is not affected. It is of course necessary to keep the water level in the chamber at the point that gives the best results, and this is found to be about 4 ft. below the top.

The venturi meter is 2 in. in diameter with a ¾-in. throat, and the average registration for 24 hr. is about 28,800 gal.

*Division Engineer, Metropolitan Water-Works, 1 Ashburton Place, Boston.

The air chamber is made of a piece of 10-in. flanged cast-iron pipe. The inlet- and outlet-pipe connections inside of the chamber were so arranged that the water could not take a short and direct course between them. It is thought that this feature has considerable effect, as it prevents pulsations from being carried through by a straight flow of water. The chamber is located about 6 ft. from the meter tube and about 165 ft. from the feed pump. It was found by experiment that the most satisfactory results were obtained when the chamber was located near the meter instead of at the pump end of the feed line.

Before the special air chamber was installed, the surges and shocks in the feed line were very severe. After it was put in operation, it was found that the life of the plunger packings was prolonged and the strain on pipes and pump greatly reduced.

Safe Grade Crossings

Six plans for making grade crossings safe have been sent out by the Railroad Commission of California to the larger railroads and to the larger cities and counties having a considerable mileage of improved roads, requesting that the plans be criticized and given a trial. Three of the schemes are shown herewith. Fig. 1 is based on a sketch submitted by the division engineer's office, Coast Division, Southern Pacific Co. Fig. 2, submitted by Scott W. Alexander, Long Beach, Calif., is of the same general type as Fig. 1, but provides no barrier requiring slower speed. Fig. 3, submitted by Charles R. Blake, commissioner of health, Richmond, Calif., involves a double right-angle turn in order to cross the tracks, depending upon this to slow down the automobile and to put caution in the driver's mind.

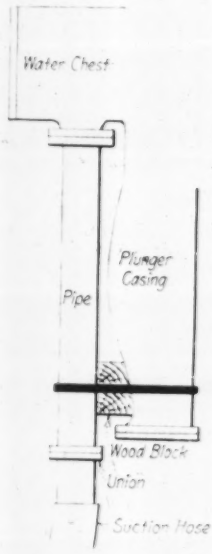
Another method, not illustrated in this article, was devised by J. H. Weatherford, city engineer, Memphis, Tenn., and depends for its effectiveness upon a soft or retarding pavement or surface for a short distance on each side of the tracks. Another design was submitted by William M. Humans, Los Angeles, and covers acute-angle roadways, railroad rights-of-way with or without parallel roadways, dangerous junctions of auto highways without car tracks, etc. The sixth plan, by F. E. Peters, Tropico, Calif., involves an elliptical park in the center of the street on each side of the track, much as shown in Fig. 2, but without the warning signs.

Plans similar to some of these approved by California are in use at the present time in other states. To be effective, the highway approach to the tracks must be laid out to *necessitate* a slowing-down of the automobile—a mere warning is inadequate.

Steadying the Suction Pipe*

By J. F. K. Brown†

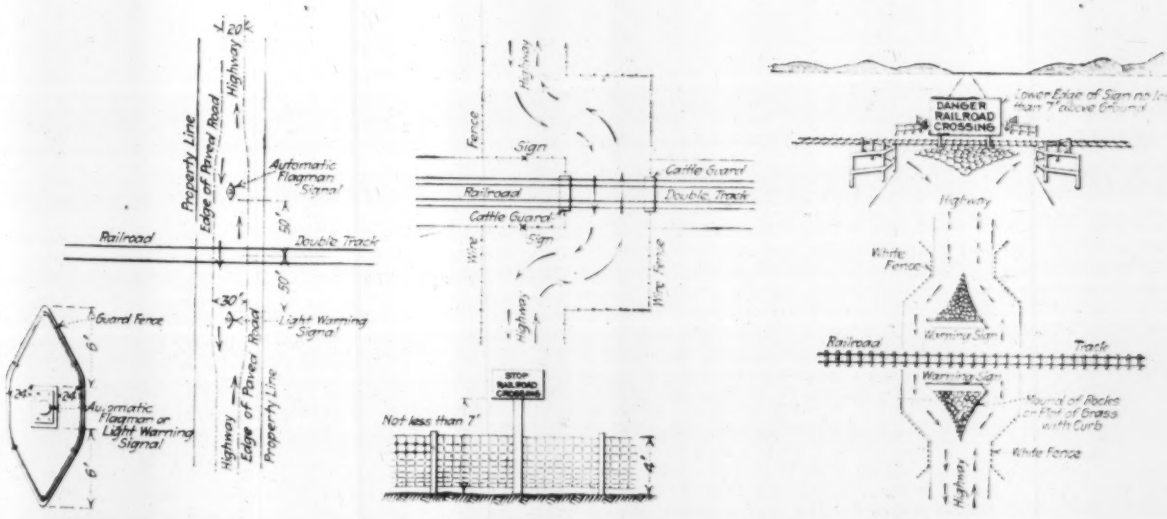
The device illustrated herewith is for use on sinking pumps, and though it may be quite contrary to common practice, I have found it useful on a number of troublous occasions. It is given here for the benefit of others having the same trouble. In sinking it has always been my custom to use a length of pipe at the suction which will reach just below the bottom of the pump, and to attach the hose at this point with a union. This has been done because there is little room between the body of the pump and the pipe in which to place a union and to take off and put on the hose. It is easier doing it just below the pump. When this pipe was first used it caused trouble by frequently breaking off where it entered the pump, because of being knocked against the sides of the shaft in raising or lowering. To obviate this a piece of wood is now inserted as shown in the drawing. This has the effect of making this piece of pipe solid with the pump throughout its entire length. Breakage of this pipe is now infrequent.



THE STEADY BLOCK IN PLACE

*From "Coal Age," Dec. 9

†Sydney, N. S.



LAYOUTS AIMING AT SAFE GRADE CROSSINGS, COMPILED BY CALIFORNIA RAILROAD COMMISSION

Short Method of Calculating Four-Sided Areas

By C. K. Averill*

The area of a three- or four-sided figure when the traverse has been closed may be calculated without any D. M. D. column or other preparation by the following method:

Course	Length	N	S	E	W	Lat. × Dep.
N 8° 10′ 20″ E.	101 20	100 17		14 38		1,440 44
S 86° 20′ 10″ E.	50 0		3 20	49 90		159 69
S 8° 12′ 00″ W.	100 0		98 98		14 26	1,411 45
N 87° 41′ 56″ W.	50 06	2 01			50 02	100 54
		102 18	102 18	64 28	64 28	3,112 12

102 18 × 64 28 = 6,568 13
3,112 12 ÷ 2 = 1,556 06

Area = 5,012 07

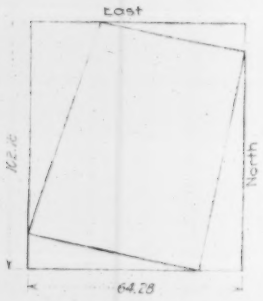
The latitude and departure of each course are multiplied together and the products placed in the column headed "Lat. × Dep." One-half the total of these products subtracted from the product of the sum of latitudes and sum of the departures will be the area.

By the usual method this calculation would be as follows:

Course	Distance	N	S	E	W	D M D	N	S
N 8° 10′ 20″ E.	101 20	100 17		14 38		14 38	1,440 44	
S 86° 20′ 10″ E.	50 0		3 20	49 90		78 66		251.71
S 8° 12′ 06″ W.	100 0		98 98		14 26	114 50		11,313.41
N 87° 41′ 56″ W.	50 0	2 01			50 02	50 02	100 54	
		102 18	102 18	64 28	64 28		1,540 98	11,565.12

11,565 12 − 1,540 98 = 10,024 14
10,024 14 ÷ 2 = 5,012 07

By reference to the accompanying sketch: The area of the inclosing rectangle is the product of the sum of latitudes and sum of departures. From this are to be deducted the areas of four triangles each of which is one-half the product of the latitude and the departure of a course. A triangular figure can be calculated by this method, but not one or more than four sides. The method is somewhat shorter than the double meridian distance method, as no columns have to be prepared and the multiplications can be started as soon as the traverse is closed. It is also a convenient check in connection with that method. It is plain that it makes no difference with which course the traverse is started, which is another advantage over the double meridian distance method.



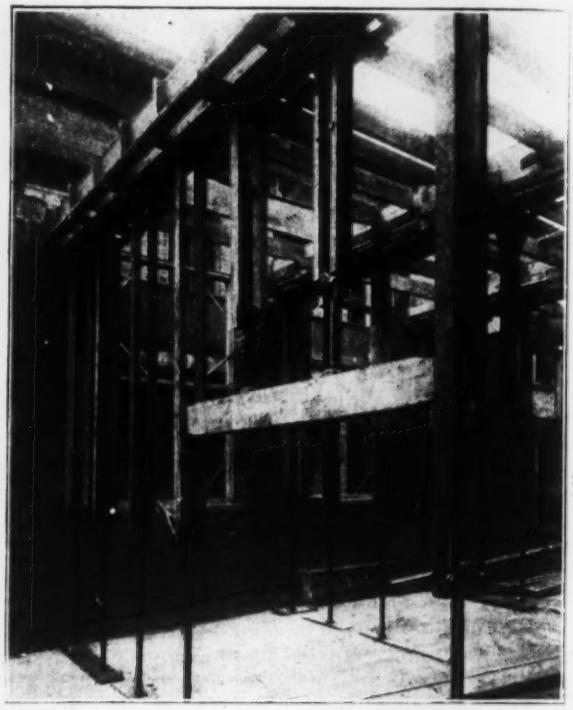
AREA TO BE COMPUTED BY NEW METHOD

FINE AGGREGATE

Inspecting Elevated Track by Periscope is used on the Queens elevated lines in peaceful New York City. The apparatus consists of a small hand mirror fastened to a stick about 3 ft. long and is stated by the "Public Service Record" to be "invaluable for inspecting and counting the hook bolts, lagscrews and all other track material located under the ties." The men engaged on this work are said to have nicknamed the device a "periscope." The original idea has been improved upon by cutting the handle about 3 in. from the mirror and jointing it with a thumbscrew in such a way that the mirror may be set at any desired angle.

*Yonkers, N. Y.

Adjustable Building Shores are becoming very popular reinforced-concrete work, several different types having been devised by various concrete specialists. The ones in the accompanying view are after a design patented by H. W. Ro of Cincinnati, Ohio, and are used in the work of his company in that city. The shore consists of two legs of 2x4's which are attached a pair of clamping yokes, which engage a piece of standard 1¼-in. pipe. The pipe is held by a he guide at the top and a base at the bottom. The operati consists merely in picking up the upper member and rai



SPECIAL SHORES PERMIT SERVICE ALLEYWAY IN CINCINNATI BUILDING

ing it to the required height. By pressing the two legs of the 2x4's together, the clamping yokes engage the pipe and the load supports itself. A portable jacking device is used to make the final adjustments, and a locking device on the yokes prevents the shores from slipping while lattice bracing is being nailed on or while the shore is telescoped for removal to other locations. A novel use of the shores, which is shown in the view, is the ease with which a lane may be left through a building under construction. The design permits the placing of the cross-beam on which foot the shores carrying the forms across the opening.

Chords for Railroad Curves Measured on Arcs—The accompanying tables of chords for use in laying out curves based on an arc length of 100 ft. per degree of curvature, instead of the usual 100-ft. chord, are sent by W. C. West, Highway Engineer, Bureau of Public Works, Manila, P. I. In each case D is taken as the central angle subtended by an arc of 100 ft.

USING ONE CHORD OF ABOUT 100 FT.

$$\text{Chord} = \frac{360 \sin \frac{1}{2}D}{\pi D^\circ} \times \text{arc}$$

D	Chord	D	Chord
0°	100.00	16°	99.68
1°	100.00	17°	99.63
2°	100.00	18°	99.59
3°	99.99	19°	99.54
4°	99.98	20°	99.49
5°	99.97	21°	99.44
6°	99.95	22°	99.39
7°	99.94	23°	99.33
8°	99.92	24°	99.27
9°	99.90	25°	99.21
10°	99.87	26°	99.14
11°	99.85	27°	99.08
12°	99.82	28°	99.01
13°	99.78	29°	98 94
14°	99.75	30°	98.86
15°	99 72	..	....

USING TWO CHORDS OF ABOUT 50 FT. EACH

$$\text{Chord} = \frac{720 \sin \frac{1}{4}D}{\pi D^\circ} \times \text{arc}$$

D	Chord	D	Chord
0°	50.00	32°	49.84
1°	50.00	34°	49.82
2°	50.00	36°	49.80
4°	50.00	38°	49.77
6°	50.00	38°	49.77
8°	49.99	40°	49.74
10°	49.98	42°	49.72
12°	49.98	44°	49.70
14°	49.97	46°	49.67
16°	49.96	48°	49.64
18°	49.95	50°	49.60
20°	49.94	52°	49.57
22°	49.92	54°	49.54
24°	49.90	56°	49.50
26°	49.89	58°	49.47
28°	49.88	60°	49.43
30°	49.86	..	....

Editorials

Prize Announcement Postponed

The editors of *Engineering News* have been unable to complete the examination of the articles submitted in competition for the prizes offered in the issue of Oct. 26, in time to announce the award in this issue. The names of the prize winners will be published next week and the paper receiving prizes, with other meritorious papers, will be published in the following issues.

A Bill To Suppress Publications of National Circulation

Since the United States first became a nation, the task that has engaged the best efforts of its ablest statesmen has been the development among its people of the spirit of national unity in place of the spirit of sectionalism.

Half a century ago, the nation's very life was threatened by the spirit of sectionalism, and four years of civil war were fought to save the Union. The history of other nations as well as that of the United States shows the vast importance of cultivating, by every means possible, common thoughts and ideals in the people of a nation.

Probably no other influence has been so potent during the half-century since the Civil War in tearing down sectional barriers and eliminating prejudices and misunderstandings between North and South and East and West as the circulation of national publications. Who can overestimate the value to the nation in the past fifty years of the circulation of such national journals as *Harper's*, the *Century*, the *Nation*, the *North American Review* and a hundred others in developing among a wide circle of readers, the country over, similar ideals and standards?

It is not often realized that the development of these publications of nation-wide scope has been made possible by the law, enacted since the Civil War, which fixed a uniform postal rate for the whole United States on all printed matter.

A bill has just been introduced in Congress as a "rider" on the Post Office Appropriation Bill, which proposes to tax national journals out of existence by placing upon all publications a postal rate based on the distance of transmission, as follows:

Up to 300 mi	1c. per lb.	1,000 to 1,400 mi	4c. per lb.
300 to 600 mi	2c. per lb.	1,400 to 1,800 mi	5c. per lb.
600 to 1,000 mi	3c. per lb.	Over 1,800 mi	6c. per lb.

That this tax, if imposed, will greatly restrict the circulation of truly national journals, there is not the slightest doubt. The daily newspapers will be hardly touched. A large part of their circulation is distributed otherwise than through the mails, and few have any considerable circulation farther than 300 mi. from the place of publication. The journals that will be seriously affected are those which know no sectional distinctions or boundaries—the very journals whose circulation should be encouraged by every statesman who understands the great importance of national unity.

A great influence has been exerted on the national development during the past half-century by the journals devoted to literature, to science and the arts, to the professions and the industries. Doubtless the Congressmen who framed this bill have no conception of what it will mean to substitute journals of a sectional character in place of the national journals that have been so important a feature of American public life.

It is only in the journals of national circulation that one can expect to find public questions discussed from the broad point of view of the nation's interests, without regard to the interests of any particular locality. Surely, this is too important a matter to be lightly passed over. Surely, the unity of the nation is something which those in authority at Washington may not lightly dismiss.

The second-class postage question has often been discussed as if the only publications affected were the so-called trade journals, but they really cut only a small figure in the whole. To bring the matter home to engineers, the change proposed in second-class postage rate will mean a very heavy tax on the circulation of the "Proceedings" of the various national engineering societies. This is only typical of what will take place in all professions. Take the medical profession, for example. How important it is in the public interest that the physicians of the country shall be informed upon the latest advances in medical science as reported in the medical journals. The country doctor living west of the Mississippi River may find it too great a burden to pay an extra bill of perhaps ten dollars a year for postage on the medical journals to which he subscribes.

It is not only the men in the professions who will be affected. The change reaches all classes of society. The labor movement, for example, relies on national journals to reach men scattered in all parts of the country. There are many religious publications that have a nation-wide circulation. The Government is spending many millions of dollars to promote education of the farmers of the country toward better and more productive agriculture. What will this tax mean in cutting down the distribution of the best agricultural publications?

It may be said that the Government should charge sufficient postage on the publications to pay the cost of their transmission through the mails regardless of their value as a means of public education. Even on this basis, the proposed zone system of rates for second-class matter cannot be defended.

The Congressmen who framed this act doubtless imagine that the variation of the postage rates with the distances which they have schemed out corresponds in some measure to the cost to the Government of transmitting the mails. But every engineer familiar with modern transportation methods knows that under present-day conditions the great element in the cost of carriage *is not the hauling over the road, but the terminal expense.* This is true of ordinary merchandise, such as hardware, groceries and dry goods. Much more is it true of mail matter,

where the post-office employees must handle each individual piece and read its address perhaps half a dozen times in the course of its journey from sender to receiver. Take, for example, a journal mailed in New York to a subscriber in San Francisco. It is placed by the publisher in a mail bag, a car is loaded to its full capacity with hundreds of bags of such mail and started from New York on its journey across the continent. It costs no more to haul that pound of mail matter across the continent than it would cost to haul a pound of meat, or fish, or coffee, or oranges, or any other item of freight shipped on a fast schedule.

It would often involve greater expense to the Post Office Department to carry a copy of the same journal to some country town within a hundred miles' distance, where it had to be handled over three or four different lines of railway and finally carried over a rural free-delivery route.

All questions as to the relative cost of the service, however, are truly insignificant compared with the proposition to place a ban on the circulation of national journals. Surely, the lessons of the European War ought not to be wholly lost on us. In Germany, in Great Britain, in France, the uppermost question is national unity. What would be thought in any of these nations of a serious proposal to stop the circulation of journals of national scope? More than at any previous time in its history does the United States need to foster in every way the development of a national spirit among its people. Every influence that tends to preserve this national spirit must be fostered at any cost.

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Bridge Engineering Discussed by Masters of the Art

This issue of *Engineering News* is made notable by the publication in the Engineering Literature section of a remarkable review of a remarkable book. The book is the recently published treatise on "Bridge Engineering," by J. A. L. Waddell, which is doubtless the most complete and elaborate work in this field of engineering ever issued. It is notable, not only for its size and completeness, but because its author stands in the foremost rank of American bridge engineers. When a book is written by one of the masters in an art, the difficulty arises of finding someone to prepare a critical review of his work who will be, at least, a peer of the author in reputation, so that he may be qualified to pass judgment upon the work and so that his criticism may carry weight with the reader.

Engineering News believes that it has rendered a notable service to the profession in securing the consent of Gustav Lindenthal, the Nestor of American bridge engineers, to review Mr. Waddell's great work. Every bridge engineer in the United States will wish to read, and read with care, Mr. Lindenthal's critical review in this issue. As will be seen, it far transcends in length the space of an ordinary book review; and it is, in fact, very much more than a book review. It is a discussion, by one of the most eminent of living authorities, of certain principles of bridge design set forth in Mr. Waddell's treatise.

While Mr. Lindenthal speaks in highly commendatory terms of Mr. Waddell's monumental work as a whole, he also sets forth very frankly a number of important matters on which he disagrees with Mr. Waddell as to the essentials of sound practice in bridge design.

Without doubt, Mr. Waddell's book is destined for many years to come to rank as an authority in its field. It is of great value, therefore, to have a critical study made of its recommendations, so that the engineer may know in what parts of the book there is a disagreement among doctors as to the soundness of the principles which are there stated.

⁂

Ship Canals To Aid the Navy in National Defense

There is general agreement apparently, that the United States can well afford to spend a vast sum of money in developing its navy as a means of national defense. Public attention has chiefly been directed toward the increase of the navy by the construction of additional vessels; but naval officers who are experts in strategy agree that the equipment of the navy with docks and shore stations properly located is just as important for efficient work in national defense as is the building of fighting ships.

A high official of the navy recently declared that an additional large dry dock for the navy, suitably located, would contribute more toward national security than an additional battleship.

At the recent annual meeting of the Society of Naval Architects and Marine Engineers a striking paper was read by Capt. A. C. Niblack, reviewing the elementary principles of naval strategy which should govern the United States in the development of shore stations and bases for its naval operations, but which neither the public nor Congress at all understands. By creating a naval base in Culebra Island just east of Porto Rico, Captain Niblack declared, as much could be accomplished for national defense as by the purchase of St. Thomas.

On the Atlantic Coast, Captain Niblack urged the importance of thorough protection for the main base, New York City, as follows:

> New York as the assumed center and Boston and Philadelphia on the periphery of the circle inclosing the main industrial area of the United States form the true strategical center. The instant we deepen the Cape Cod and the Delaware and Raritan Canals into ship canals and clear the East River of all obstructions from the Battery to Long Island Sound and adequately fortify Block Island, Vineyard Sound, Buzzards Bay and the Cape Cod Bay region, with exits at Delaware Bay, Sandy Hook, Block Island and Massachusetts Bay, the entire British navy as it exists today could not blockade our own navy as it is.

Captain Niblack further urged that, to protect the national capital and the important naval base at Norfolk, the entrance to Chesapeake Bay should be adequately defended, as well as the entrance to Delaware Bay, and the Delaware & Chesapeake Canal should be made a ship canal.

The average citizen and even the average engineer has little understanding of the problems of naval strategy, but it is easy even for a layman to comprehend the advantage of this long interior line of communication for a fleet acting on the defensive against a superior fleet operating outside.

As many readers of *Engineering News* will recall, complete surveys were made some years ago by the army engineers for a ship canal across New Jersey, extending from Raritan Bay to the Delaware River. A most favorable route was found for a sea-level canal that would offer a minimum of interference to existing railway lines, while

nearly all the material could be removed at low cost by modern machinery for earth excavation. With the completion of this channel and the comparatively short ship canal between the Chesapeake and Delaware Bays, it would be possible for vessels of all classes to traverse the entire distance from Buzzards Bay to Norfolk without exposure to the risks of the open ocean. This extension of the territory available for barge navigation would add greatly to the value of the New York barge canal across New York State, soon to be ready for traffic.

Future Sources of Liquid-Fuel Supply

Investigations by the United States Geological Survey indicate that the known petroleum deposits of the United States are sufficient to supply the demand at the present rate of consumption for only about 30 years. While this investigation takes no account of the output from new oil fields, it also takes no account of the steady increase in consumption of oil fuel which is all the time going on. Of course, long before the supply is exhausted, a great advance in the price will occur; and as everyone knows, an increase in price has already taken place. Recent quotations for standard grades of crude oil in the Eastern markets have been the highest recorded since the Civil War. Agitation concerning the advance in the price of gasoline has been country wide. Only the development during the past five years of the enormously productive oil deposits of Mexico has prevented a fuel-oil famine and a much greater increase in price.

It is obvious that, if the supply of liquid fuel is exhausted, the consequences will be far reaching. The industrial and engineering world is just adapting itself to the use of the liquid-fuel motor in a hundred different fields. To have the fuel supply for automobiles, motor trucks, motor boats, gasoline engines, pumps, etc., suddenly cut off or even doubled in price would be a most serious matter. For example, many hundreds of millions of dollars are being expended to build roads adapted for motor vehicles. Were the motor vehicle to become obsolete for lack of fuel supply, a great part of this expenditure might be wasted. It is therefore of great importance to determine as far as possible what source may be available to supplement the stock of liquid petroleum when it is exhausted.

A great deal has been said concerning the possibilities in using waste vegetable matter for the manufacture of alcohol as an engine fuel. This has been done to a considerable extent in Europe, where high prices for gasoline have made the process commercially feasible. Something of the same sort may perhaps be done in this country when the price of gasoline rises sufficiently high. The difficulty to be met is that means are being found of utilizing in other ways the vegetable matter that was formerly a waste product. The refuse molasses from the sugar plantations, which was formerly burned to get rid of it and was later used on a large scale for industrial-alcohol manufacture, is now taken for stock feeding. The bagasse, or crushed cane, discharged by the sugar mills after the juice has been extracted from it, commonly serves as fuel under the boilers, but a beginning has already been made in its utilization for paper manufacture.

Over a quarter of a century ago the late Prof. N. S. Shaler, in his famous book, "Man and the Earth," pointed out that, when the nation's petroleum wells are exhausted, the enormous deposits of bituminous shale, several hundred feet in thickness, underlying a considerable part of the Mississippi Valley, will be capable of producing oil by distillation. The increasing urgency of the liquid-fuel situation makes the possibilities in shale distillation of renewed interest. The Geological Survey on Dec. 18 announced the results of recent investigations of the oil-shale deposits in the Green River Formation in Colorado, Utah, Nevada and Wyoming, as follows:

> In northwestern Colorado alone there is sufficient shale in beds at least 3 ft. thick and containing more oil than the average shale now mined in Scotland to yield about 20 billion barrels of crude oil, which is more than five times the total amount of crude oil produced in the United States to date. In Utah there is probably nearly as much shale just as rich. This shale oil will yield 10 to 15% of gasoline by ordinary methods of refining.

The distillation of bituminous shale to obtain oil has been a prosperous industry in Scotland for three-quarters of a century, notwithstanding the competition of petroleum. As long as crude petroleum was sold at a dollar a barrel or less, it has been impossible profitably to exploit the oil-shale deposits of the United States. With the increasing demand and higher prices for oil, a great industry should grow up in the production of oil from shale.

Do Engineers Need To Eat?

The recent report of the Detroit Bureau of Governmental Research on Detroit sewer construction contains some interesting sidelights on what is considered fair compensation for the lower grades of engineering service. It is the more interesting because it was written by a graduate civil engineer (Massachusetts Institute of Technology) of 13 years' experience, most of it in municipal work. The report states:

> As compared with similar positions throughout the country a salary of $1,500 per year for chief of survey party (giving lines and grade for sewers and sidewalks) is a little above the average. However, increased responsibilities through absence of constant support from the sewer engineer, together with a recognition of the high cost of living in Detroit [written in September, 1916], would warrant this or a slightly increased salary. A leveler at $1,400, even though he be proficient both as a leveler and transitman, is overpaid. In most places $75 per month is paid for such services, unless the duties include charge of party. Certainly, a maximum of $100 should secure a first-class man for this position. A salary of $1,200 for the position of rodman is out of all proportion to the duties involved, regardless of the ability of the rodman. . . . Young ambitious graduates of technical schools are eager for such experience and can be secured at a compensation of $85 per month, and undergraduates for even less.

The minimum price now paid for common day labor everywhere is $2.50 per day; in most large cities and probably in Detroit it is nearer $3 per day. In Detroit also is the Ford automobile plant, where the minimum wage for man, woman and child is $5 per day. Let us see; a daily wage of $3 for six days a week is a little better than $85 a month, which "young ambitious graduates of technical schools are eager for." The graduate's little sister may be employed by the Ford company or some other prosperous manufacturing concern as a stenographer at $5 per day, or $125 per month, or $1,500 a year, which our municipal investigator—an engineer, too—considers a little extravagant for a chief of party, a technical graduate of three or four years' experience, we will say. This is indeed being wounded in the house of our friends.

Letters to the Editor

Proposed 30-Mile Tunnel Under the Cascade Range

Sir—General Chittenden's article on his suggested 30-mi. tunnel under the Cascade Mountains, in *Engineering News* of Nov. 16, is extremely interesting. The writer believes, however, after his experience of four years from 1901 to 1905 on this particular division of the Great Northern, that the 12-mi. tunnel from Scenic Hot Springs to Merrit would be preferable.

This tunnel was first suggested in 1901 by the late W. D. Scott and was several times discussed by the late

VIEW ON THE GREAT NORTHERN RY. NEAR WEST PORTAL OF PROPOSED 30-MILE TUNNEL

Alex Stewart and the writer while we were having so many snowslides on the west slope. All of our snow and fire troubles up to 1905 took place between Scenic and Merrit, so that the shorter tunnel would have served the purpose fully as well as the 30-mi. tunnel. The writer still agrees with Messrs. Scott and Stewart that the 12-mi. tunnel would be sufficient.

Should the 30-mi. tunnel ever be constructed, one of the greatest troubles will be from excessive water. The entire west slope of the Cascades is subject to heavy rainfall, and during the winter the snow falls at the rate of a foot an hour at times. Large amounts of water were struck on the present 2.6-mi. Great Northern tunnel, and a million gallons per day were discharged from the west portal when the writer built the portals in 1901. There were no lakes or creeks anywhere near the line across the mountain over the tunnel.

The granite of the Cascade Range is badly faulted; and as the line of the suggested 30-mi. tunnel passes directly below many lakes and mountain torrents, the amount of water to be taken care of would be a serious engineering matter and possibly an actual menace to traffic.

The accompanying photograph shows something of the country on the Great Northern line near Foss Creek, about where the west portal of the 30-mi. tunnel would be located.

FRANK B. WALKER.

84 State St., Boston, Mass., Nov. 22, 1916.

The Ohio Conservancy Act

Sir—General Chittenden's instructive article in *Engineering News* of Nov. 9, entitled "The Battle over the Miami Flood-Prevention Plans," leads me to present the results of my experience in another such battle fought under the Conservancy Act of Ohio.

The great State of Ohio, stricken in 1913 and 1915 by unexampled floods, is attempting the part of a pioneer in the construction and management of public works, although its people are probably unconscious of this feature of the situation.

The subject has thus become one of broad general interest. It revives the great question: How shall public works within the United States be planned and built? Shall what has been called "the commission habit" be continued and added to, or shall there be a *permanent* department of government—national, state, county and municipal—charged with the duty of planning, constructing, operating and maintaining public works?

Whoever drew the Ohio Conservancy Act undoubtedly had a difficult task before him, and being a lawyer, had but few law-making precedents to guide him. That he did as well as he did, is to be wondered at; that the act has stood the test of Ohio's Supreme Court as to its constitutionality shows it to have been the work of no mean draftsman; that it fails lamentably, as I shall endeavor to prove, in promising to do the greatest good to the greatest number, at a minimum expenditure of public money, is but the natural result of an apparent lack of a proper and practical knowledge, on the part of the draftsman, of the conception and administration of public works.

Let us briefly review the act. It provides for the appointment in any county of commissioners. Note that two mistakes have already been made, for: (1) County lines are no proper boundary of jurisdiction in matters of engineering construction, especially not for flood protection; (2) nor is an emergency commission of laymen a proper body to oversee to the best advantage the design, construction, operation and maintenance of such works.

The act provides, to be sure, that the commission appointed may enlarge its jurisdiction into, perhaps over, adjoining counties; but that is a bungling method of

avoiding the natural demand for including, in the case of such hydraulic works, in the jurisdiction of the supervising body, for engineering and construction purposes, the *drainage area* of the river the inhabitants of whose valley are to be protected from floods, and nothing more or less.

That is, it should not be possible to locate two or more independent conservancy commissions within the drainage area of any of Ohio's principal rivers. Some glimmering of this idea appears to have been present in the minds of the legislators when it was provided that several conservancy districts might be forced to unite or be united. But that may prove, as an afterthought and from the human side of the situation, to be a difficult matter to accomplish.

The law should operate *on drainage areas*, not on counties or on parts of counties or on parts of drainage areas. The latter feature has brought with it in Ohio the spectacle of nine county judges sitting as engineers to test the propriety of constructing works laboriously designed after three years of work by presumably able engineers at a cost of some $750,000. These plans have been made under the mandate of a board of commissioners appointed for the purpose of recommending to the people the best and most economical method and structures for protecting their property from damage by floods.

In what way, it may be asked, can these nine judges be more skilled as engineers than were the three conservancy commissioners, let alone the engineer whom the commissioners employed? If the commissioners had doubts in the matter, a numerous profession of consulting engineers could surely have aided them, and by a more rational procedure than that of a court with its public exhibition of questions and answers.

Other fundamental defects in the act have been referred to and may be illustrated. On the Scioto River is another conservancy district, for which has been made an able engineering report by John W. Alvord. Adopting the method of detention reservoirs, he designed the construction of two such reservoirs, which together with the use of two natural detention reservoirs (one of them the Great Marsh, 15,000 acres, in Hardin County) would suffice to protect the whole valley from flood flow. Of course, such a group of reservoirs must be in balance among themselves and with the flood flow from the territory they are to protect; but along comes another conservancy commission, organized under the same Conservancy Act, but having for its jurisdiction only a small part of the Scioto drainage area, and calmly proceeds to condemn the Great Marsh to cease to operate as a detention reservoir. No concern of theirs that this would spoil the plans of the Franklin County conservancy commissioners, for they are looking out only for their immediate clients or petitioners, the owners (or some of them) of the Great Marsh, who want the marsh drained. Incidentally be it noted that the proposed drainage plans do not even "conserve" the marsh. (This is the marsh near Kenton, Ohio, which a sympathizing public throughout the United States was recently called upon, by the Associated Press, to bewail, because it was on fire, and which may be burning yet, as it did for weeks.) Both for purposes of flood protection and to "conserve" the marsh, what is plainly needed at the outlet of the marsh is a dam, not a drainage canal, which latter would aggravate the floods and flood damage downstream from the marsh; a low dam, its crest 18 in. or 2 ft. below the general level of the marsh; sluice gates and culverts through or in it, if one likes, so that by the operation of these gates, or of flashboards on the dam, or of both, one could either to a sufficient agricultural extent drain the marsh or, when necessary (as to put out bog fires) flood it; or let flood flows pass by to the same amount per day that they now do, and no more.

I have been told that it was proposed for the case named to have a hydraulic engineer sit with the judge as an "assessor," as it is called, to aid the judge with his expert knowledge; for evidently in such a situation the presiding tribunal should be learned in the subject matter and not be hampered by having only testimony, even though it be "expert or opinion testimony," to rely upon. But the project failed, because the act does not provide for the payment of such an *amicus curiae*.

I come back to the thoughts expressed at the beginning of this letter. In the complex civilization under which we live, methods of constructing the public works of commonwealths which sufficed in colonial or pioneer days no longer serve; and to a still greater degree is this true of the operation and maintenance of such works. We are approaching the day, if it is not already here, when *permanent* organizations for the construction and care of all public works will have to be provided for—in the Cabinet at Washington; in the capitals of the several states; in counties, if one likes; and in the municipalities of the nation.

CLEMENS HERSCHEL.

New York City, Nov. 25, 1916.

Turning Moments on the Quebec Suspended-Span Supports

Sir—Since my letter regarding the Quebec Bridge accident was published in *Engineering News*, Nov. 2, it has been pointed out that if the counterbalancing effect of the dead weight of the lifting girder were taken into account, it would take 0.34 in. instead of "slightly more than one-eighth of an inch" to make the top of the girder tend to assume a slope of 5%. An eccentricity of ⅓ in. would produce a moment of 800,000 in.-lb. As it would require a moment of 1,920,000 in.-lb. to overcome the friction (assumed at 20%) on the 8-in. pin, above the rocker casting, it is plain that even if a ⅓-in. eccentricity existed, some further turning moment would be required to overcome pin friction.

Among the conditions that might be suggested as possibly producing a turning moment the following has been mentioned: When the suspended span was floated under the cantilever arm and moored by wire-rope guys to the mooring trusses, it is possible that the center of gravity of the span might have been a foot or more north of a point halfway between the jacking girders of the north and south cantilever arms. The guys at the ends might have been tightened up with the span in this incorrect position. Then, when the chains were attached, the pins in them would be in a catenary having its vertex at the point of attachment. With the falling tide the weight of the span would be transferred from the barges to the chains, and at the same time a considerable stress would be put on the guys to the north mooring truss. As the jacking proceeded and the span rose, the guys to the north mooring truss would revolve around their point of attachment to the mooring truss, and the center of gravity

of the span would move south toward the point halfway between the jacking girders of the north and south sides. This horizontal movement of the bottoms of the hanger chains would produce bending moments in the chains and a resultant moment tending to turn the lifting girders about the 8-in. pin, above the rocker, out from under the span. If the eccentricity of the center of gravity of the span be assumed as 3.5 in., the resulting moment tending to overcome friction on the 8-in. pin is as follows (see Fig. 2). Pin friction is assumed to prevent rotation on any of the 12-in. pins, and a constant moment of inertia of the chain is assumed.

$$\frac{Wl^3}{3EI} = 3.5$$

$$W = \frac{3 \times 30{,}000{,}000 \times 9 \times 30 \times 30 \times 30 \times 3.5}{150 \times 150 \times 150 \times 12 \times 12 \times 12 \times 12} = 1{,}100$$

$$M = 1{,}100 \times 150 \times 12 = 1{,}980{,}000$$
$$-1{,}100 \times 4 = -4{,}400$$
$$1{,}975{,}600$$

Though this moment is enough to produce rotation of all four lifting girders under the transverse 8-in. pins, it depends on constant moment of inertia of the chains, whereas that is considerably reduced at the pin points in the chains, and a greater eccentricity than 3.5 in. would be necessary to produce rotation.

If the coefficient of friction on the greased longitudinal pin under the casting be 8% in a longitudinal direction, and if it requires about 2% additional to bend the centering plates, an initial eccentricity of 4¼ in. of the center of gravity of the span would be required theoretically to cause a lifting girder to slip out under the span. It would seem that there would be first turning on the 8-in. pin and then sliding on the 9½-in. longitudinal pin. In this hypothesis it is necessary to assume some disturbing elements at the southwest shoe, more serious than at the other points, particularly at the southeast shoe. It might have been that the 8-in. pin was eccentric with respect to the lowest 12-in. pins in the chains. It might have been that the lifting girder did not hang plumb. It might have been that the casting broke, though it was subjected to less stress from combined external direct and bending forces than it was at Sillery Cove.

There were other forces acting on all four points. The south end of the span was 2 ft. higher than the north end and this rotated the lifting girders slightly. From the time the chains were attached till the time of the collapse a possible temperature expansion of 2½ in. took place, pushing the bottom of each chain 1¼ in. with respect to the jacking girders, away from the center of the stream. Continual shortening of the chains would aggravate turning moments produced by these two circumstances, and in the above hypothesis the two conditions would aggravate the moments at the south lifting girders and improve them at the north lifting girders. Bending stresses in the girders, bending the top flanges transversely, and the slight strains would produce, or would aggravate, an eccentricity of the 8-in. pin, with respect to the 12-in. pins.

The assumptions made in designing the casting may be open to criticism, but in determining the stresses to which good castings already made must have been subjected it would seem necessary to make a lenient assumption as to the distribution of the external forces. The distribution curve would presumably be smooth, but on account of the distribution of the metal a good portion of the load would naturally come down direct where there was the most metal.

If a smooth curve, such as is shown in Fig. 1, be assumed and then be approximated by the straight lines, the computed stresses due to direct load, at Sillery Cove, would be 20,600 lb. per sq.in. tension at the root of the bracket and 38,000 lb. per sq.in. at the center. If the stresses due to expansion of the span (coefficient of friction equal to 8%) be added, they are respectively 24,330 and 44,950 lb. per sq.in. At the bridge site the stresses due to direct load would be 18,700 lb. per sq.in. and 35,400 lb. per sq.in. respectively; and if the stresses due to bending loads (friction equal to 8%, plus centering plates equal to 2%) are added, they would be 22,950 lb. per sq.in. and 43,200, lb. per sq.in. respectively. The above stresses are high, but from a consideration of the tensile strength of cast steel, which varies from 33,000 to 99,000 lb. per sq.in., and of the tests on cast iron, summarized in Johnson's "Materials of Construction" in Table XXIV, p. 478, where cast iron varies in tensile strength from 12,688 to 32,821 lb. per sq.in., and in cross-bending from 25,820 to 47,710 lb. per sq.in., it would seem that good rocker castings would be able to withstand the above computed stresses, especially if, as many would believe, the root of the bracket is practically the weakest point. If the southwest rocker was faulty and contributed to the failure, it would seem probable that cracks had started at Sillery Cove, though they might be invisible.

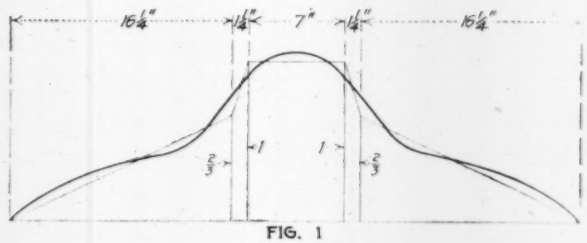


FIG. 1

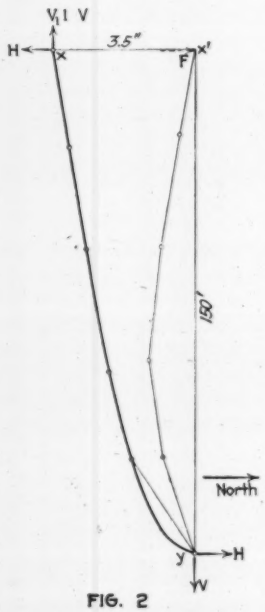


FIG. 2

FIGS. 1 AND 2. ROCKER-LOAD AND CHAIN BENDING - MOMENTS

Fig. 2—Before V is applied the 12-in. pins are on the catenary. If the point x is moved 3.5 in. north with respect to y the force F necessary to produce such a deflection may be computed. Then the moment at y produced by F can be computed

Possibly, some of the foregoing might be the occasion of bringing out facts that would throw light on the cause of the disaster.

ROBERT S. FOULDS.

Phoenixville, Penn., Nov. 9, 1916.

Charges for Use of Sewers

Sir—On page 512 of *Engineering News* of Sept. 14, 1916, you published some editorial comments on "Making Water Consumers Pay for Sewer Services" and quoted a statement by George G. Earl, of New Orleans, to the effect that sanitary sewers are merely carrying off the water that the water-works bring in.

If the water consumer is to pay the cost of sewerage as well as of water-works service, then the charge for the water should be so proportioned that every water taker pays in part for the sewerage service. This is unjust to water takers who do not have a sanitary-sewer service, and also to such residents as use the city water for sprinkling, manufacturing, etc. I presume that one of the reasons for not charging for sewer service is the lack of a medium to measure the liquids run into the sewer. With a 100% metered water-supply, as in Manila, this difficulty is, however, done away with.

Seven years ago the writer drew up an ordinance for the new sewerage system of Manila, establishing a sewerage charge based on the amount of water entering the property through the meter, except that for water not reaching the sewer a separate meter might be installed, on which no sewerage-service charge would be made. There were a few objections when the ordinance was first enacted, the chief one being that the price of water had been raised. After a few explanations the justice of the charge was accepted. This ordinance has been in existence since 1909 and has given satisfaction and justice to all served.

In 1915 I was passing through Honolulu and saw a sign in the City Hall window, "Sewerage charges due." I called on the superintendent to learn the basis of the charges. He stated that, not having universally metered services, they charged various prices for various kinds of services and that there always was considerable argument with the residents as to the classification. I believe that with some little study a just arrangement can be made to charge for this service, even if there are no meters.

A. GIDEON,
Superintendent of Water-Supply and Sewers.

Manila, P. I., Oct. 25, 1916.

Comparative Costs of Concrete and Mill Construction

Sir—As a contribution to the current discussion of the comparative cost of mill building and concrete construction, I append a comparison of the estimated cost of a combination steel skeleton and wood joist building, and an alternate design of reinforced-concrete skeleton construction for the same building, which was located in Wilmington, Del.

The dimensions of the building were 45x65 ft. in plan for two floors and roof, with a wing 16x60-ft., one floor and roof. The plans, as drawn by the architect, showed steel columns and girders with wood joists, flooring and wood lath. The walls were 12x8-in. hollow tile with stucco finish outside. I made a redesign of the structural part of the building, keeping the same architectural effect as originally shown, substituting reinforced-concrete columns and floors and metal lath for the wood lath. This redesign was a thoroughly fireproof building, while the original was not. The itemized costs are given in the accompanying table.

The total area of the floors and roof is 10,695 sq.ft., making a cost of $3.23 per sq.ft. for original design, as

COMPARATIVE COSTS OF MILL-BUILDING AND REINFORCED-CONCRETE DESIGN FOR SAME STRUCTURE

	Original	Redesign
Permit, bonds, insurance, shoring, pumping, foreman and watchman, miscellaneous expenses, etc.	$2,996	$2,985
Lumber	1,507	987
Millwork	2,500	2,500
Carpenter labor	3,095	2,595
Demolition, excavation and stone masonry	2,854	2,854
Brickwork	5,337	4,337
Cut stone	331	331
Ornamental terra-cotta work	1,858	1,858
Structural steel	4,759	
Reinforced concrete and cement	2,600	6,569
Ornamental iron	874	874
Dahlstrom door	288	288
Ash hoist	165	165
Stair work (wood)	185	185
Tile	192	192
Weather stripping	63	63
Roofing and sheet metal	317	317
Plastering	2,998	3,100
Hardware	618	618
Painting and glazing	984	984
	$34,521	$31,802

against $2.97 per sq.ft. for the redesign. This shows a saving of 7.9% in favor of reinforced concrete.

The table is compiled with actual sub-bids received and used in the make-up of the estimate.

LOUIS MUHLHAUSEN.
1029 Brown St., Philadelphia, Penn., Dec. 1, 1916.

NOTES AND QUERIES

The Steel Column Forms used in the American Tool Works' building at Cincinnati described in "Engineering News," Nov. 23, 1916, p. 991, were for the most part furnished by the Blaw Steel Construction Co., Pittsburgh, Penn. The Hodges form, described in the article, was used only for some special locations.

The Galveston Causeway decision report on p. 1153 of "Engineering News," Dec. 14, 1916, was slightly in error when it said that a "Board of Engineers is to decide upon the proper structure." This Board originally had the decision to make, but, not being able to agree, called in the Board of Arbitration and agreed to abide by the decision of at least two out of the three arbiters. The unanimous report of these arbiters, as noted in the last issue, is therefore final.

Single-Track Concrete Roads with Turnouts—A correspondent wishes information on highway practice where narrow concrete pavements have been used with provision, say every 500 ft., for an additional width of 6 ft. for a length of 40 ft., to be used as a turnout. Data are also wanted on the advisability of constructing concrete-paved roads without shoulders. "Engineering News" will be glad to receive information from engineers who have had experience with these types of road construction.

Position-Light Signals on the Pennsylvania R.R.—In the article on the new position-light signals of the Pennsylvania R.R., in "Engineering News," of Nov. 9, the operating voltage was stated incorrectly. The signals are operated with 11-volt current by day and 6-volt current at night. The day voltage is used on foggy nights. The term "signal track" tunnel (on page 878) is an obvious typographical error for "single-track" tunnel. The explanation (on page 877) of the signal indications in the photographic view, Fig. 2, is also incorrect, due to the fact that no explanation was sent with the photograph. It was assumed that this was the equivalent of a two-arm home and distant signal system, but as a matter of fact it is a three-position system. The description should read as follows: "In this view the east train has just set the right-hand signal at 'stop.' The left-hand signal indicates 'proceed prepared to stop at next signal' (one block being clear). When the train passes out of the second block, the bottom row will show vertical with top row diagonal, giving indication 'proceed, prepared to pass next signal at medium speed.' When the third block is clear the top row will be vertical and bottom row horizontal, indicating 'proceed.' The blocks here are 3,500 ft. long."

Electric-Driven Cement Mill of Oregon Portland Cement Co.

By D. C. Findlay*

On June 1, 1916, the Oregon Portland Cement Co. made the first barrel of cement ever manufactured in Oregon. The plant is located at Oswego, Ore., approximately eight miles south of Portland on the Southern Pacific and on the banks of the Willamette River, thus affording alternative transportation of the finished product. In equipping the plant all the most modern features of cement manufacture have been adopted, and every effort has been made to secure a dustless plant. That it is a really dustless plant can readily be appreciated when it is stated that the photographs here reproduced were taken when the plant was running full blast, and only a faint trace of vapor is noticeable from the top of the stack shown on some other photographs of the exterior taken at the same time but not reproduced here.

The entire construction is of reinforced concrete, even including the roofs, practically eliminating depreciation and fire hazard. Because of the economical layout of the plant only 40 men are required to operate it, which is considerably below the average number required for the ordinary 1,000-bbl. plant. Further, while this is normally a 1,000-bbl. plant, 1,200 bbl. a day are being steadily turned out and sometimes as many even as 1,300 bbl. Another feature is that one barrel of cement is obtained for each 8.4 gal. of crude-oil fuel, which is considerably below the average.

This plant uses electric drive entirely. The entire electrical equipment was supplied by the Westinghouse Electric and Manufacturing Co., of East Pittsburgh, Penn., and was installed by the cement company.

In the manufacture of cement at this plant, two kinds of rock are used—lime rock from Roseburg, Ore., running about 96% $CaCO_3$; and a cement rock from Dallas, Ore., running about 60%. This rock is first fed to a No. 7½ Austin gyratory crusher driven by a 75-hp. squirrel-cage induction motor. It is then elevated and stored in 10 circular reinforced-concrete storage bins 69 ft. high and 22 ft. in diameter, with 6-in. walls. These bins hold 12,000 tons. From the bins the rock is elevated by a belt conveyor and discharged into feed bins over the kominuter. In this mill, which is driven by a 150-hp. motor with "Lenix" drive (a short belt with a ball-bearing idler in a counterweighted frame), the proportioning of the two rocks is done by two automatic feeders discharging into the kominuter, into which a stream of water is also fed.

The final grinding is done in two cylpeb tube mills using small steel cylpebs and driven by 200-hp. motors, also with "Lenix" drives. These mills take their feed from a reinforced-concrete feed trough built as a unit with the floorbeams and having an agitating shaft and paddles.

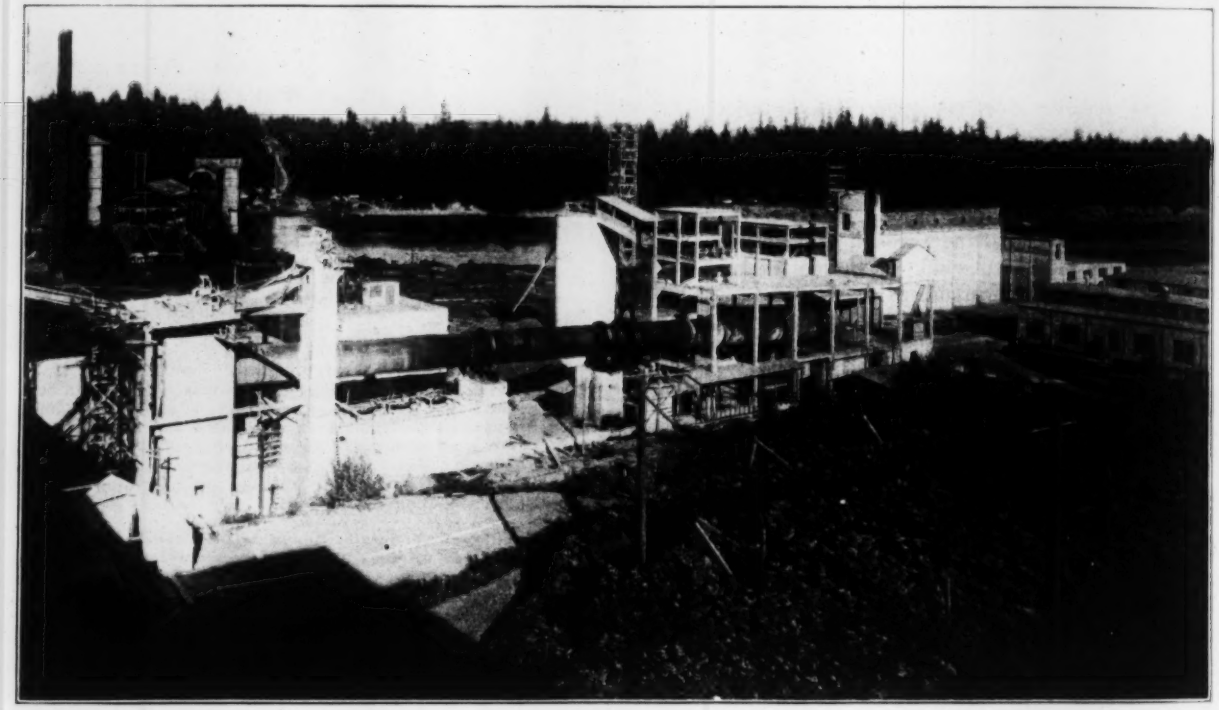


FIG. 1. GENERAL VIEW OF OREGON PORTLAND CEMENT PLANT AT OSWEGO, ORE.
Looking east, showing 210-ft. kiln and plant location on banks of Willamette River

Three circular correcting basins 24 ft. in diameter permit the chemist to vary his feed until he gets 76.6% $CaCO_3$ when mixed in the agitating basin below. An air-lift pumping system is used for pumping the slurry over to a 2,000-bbl. reinforced-concrete storage basin under the kiln. This basin is built partly above and partly below ground. It is 26 ft. deep, and the kiln piers are part of the structure. The plant is unique in that pumps have been discarded for feeding slurry to the kiln; a double reinforced-concrete continuous bucket elevator is used. The slurry stands at the same level in

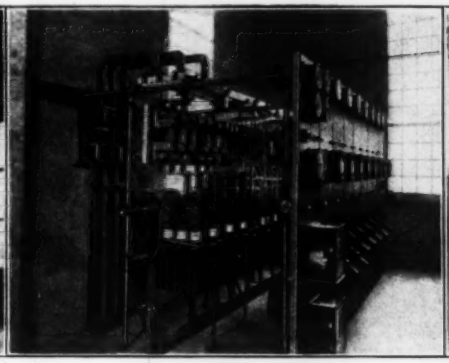
*Electrical and Mechanical Engineer, Oregon Portland Cement Co., Oswego, Ore.

the elevator as in the basin and exerts a great pressure on the walls. This elevator has proved very economical, as it requires little attention and is much cleaner than pumps.

A mechanical feeder lifts out a definite amount of slurry at each revolution and feeds it into the rotary kiln, which is 210 ft. long by 9 ft. and 10 ft. in diameter, being the largest kiln on the Pacific Coast. It rests on five tires and weighs about 500 tons. It is driven by a 75-hp. variable-speed motor located under the burners control. Crude oil is used, with air at 2 lb. pressure for atomizing (Fig. 5). The kiln is rated at 1,000 bbl.; but as previously stated, it easily produces 1,200 bbl. per day and requires only two men to operate it on each shift.

The clinker is cooled by a Smidth horizontal pressure cooler, using a blast of air from a 12-ft. diameter pressure fan. Another novelty in this plant is the method of handling the clinker, using No. 480 drag conveyor chain in a cast-iron-lined reinforced-concrete trough and discharging into a reinforced-concrete elevator leg from which a belt conveyor takes it to circular storage bins holding 6,600 bbl. each. In this condition, as soon as the clinker is ground fine enough, it becomes the finished cement. A kominuter and a 22-ft. tube mill in the grinding department grind 1,200 bbl. per day with two men on each shift of 12 hr. each. The kominuter is driven by a 150-hp. motor with "Lenix" drive. The tube mill is driven by a 250-hp. motor with "Lenix" drive. While the use of "Lenix" drive is not new, this is a notable installation in that the motor drives the tube mill through a 24-in. belt with only a 7-ft. distance from center line of driving pulley to center line of driven pulley.

From the storage bins, which are of reinforced concrete, the cement is drawn off and packed into sacks as required.



FIGS. 2 AND 3. INTERIOR VIEWS IN SUBSTATION OF MILL

Showing in left view two 1,000-k.-va. three-phase transformers disconnecting switches and high-tension bus, and in right view switchboard and bus structure

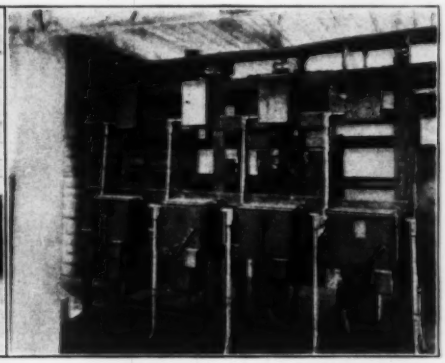


FIG. 4. VIEW OF CENTRALIZED CONTROL IN FINISHING DEPARTMENT

One operator controls large part of plant

Substation and Equipment

Power for operating the plant is purchased from the Portland Railway, Light and Power Co., on a basis of maximum demand for a 20-min. peak. It is received from the company's transmission line as three-phase 60-cycle 57,000-volt current through a three-pole air-break 60,000-volt switch mounted on a two-pole structure 8 ft. from the rear of the substation wall. The power enters the substation through aluminum outdoor-type choke coils and Locke high-voltage roof insulators to a high-tension bus suspended by disk insulators from the concrete roof slab. The high-tension bus and all the 57,000-volt wiring consist of ½-in. galvanized conduit instead of copper tubing, greatly reducing the cost of insulation. All joints in the conduit were cleaned with gasoline and the couplings sweated to the pipe, insuring as good conductivity as the pipe, which has sufficient carrying capacity for the high-tension current. Taps are taken off this bus to three single-pole knife switches leading to high-tension series relays mounted vertically on insulators. The low-voltage relays are mounted horizontally on a 6-in. channel and are operated by means of insulating links. The latter are 66 in. long, but the channel is provided with adjusting screws to regulate the exact length of the links for tripping. These relays have inverse time limits operated by bellows, which prevent them from short-circuiting the magnet coil employed for keeping a 60,000-volt oil circuit-breaker in closed position. The magnet coil also has a snap switch on the back of the board in its circuit, to enable the operator to trip the switch from the board when desired.

Disconnecting switches mounted on the back of the same structural-steel framework over the circuit-breaker, which supports the relays, connect to a transfer bus suspended from the roof. From this, taps are taken to two three-phase 1,000-kv.-a. water-cooled transformers (Fig. 2), which step down the current from 57,000 to 480 volt. They are Y-connected with grounded neutral and have four high-tension taps. Only one transformer is used at a time, the other being held as an emergency spare, disconnected from the line on both sides.

The power leaves the transformers through cables that drop through fiber bushings into the basement and pass through a novel type of disconnecting switch, consisting of two 3-pole 1,500-amp. unfused knife switches, with quick-break clips, mounted face to face in the ends of a steel cabinet supported on a concrete slab, which in turn is on piers about 5 ft. from the floor. The bottoms of the switches are tied together with heavy copper straps, and the busbar copper rises vertically from the middle of this through slate-protected openings in the top. The main busbar then passes horizontally under the floor-beams through the floor and directly to the switchboard distribution busbars.

Cable-type current transformers are mounted on the vertical rise of the busbar on an iron frame that supports both the power company's and the cement company's transformers. The secondary leads are taken in conduit through the floor and directly to the bottom of the totaling panel on the switchboard. Potential transformers for operating the control circuit of the curve-drawing wattmeters are mounted under the floor slab in the basement, directly below the switchboard.

On account of inability to procure solid busbar copper in Portland or vicinity the expedient of taping together twenty No. 1 solid bare copper wires into a busbar was adopted, connecting them at all angles with red-brass castings having the wires securely soldered in.

The substation is protected by a bank of four tank electrolytic aluminum-cell lightning arresters, mounted inside the station, but with horn gaps and transfer switch

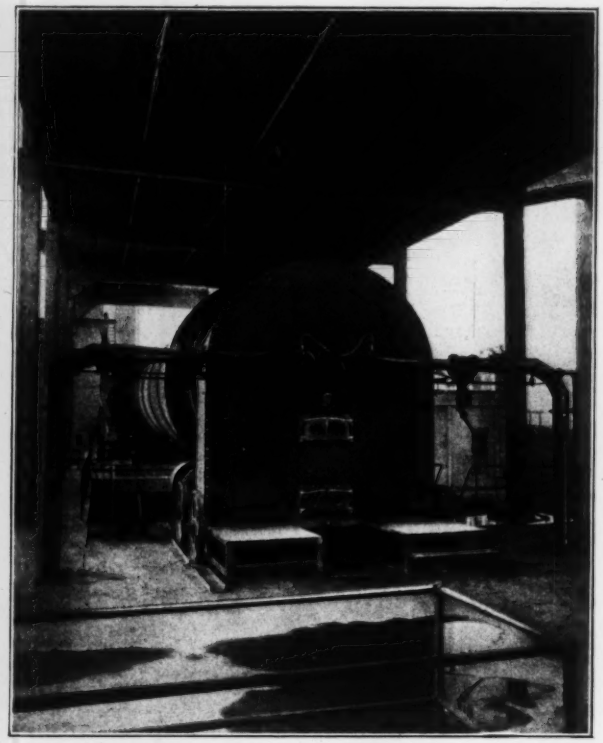


FIG. 5. END VIEW OF KILN, SHOWING CRUDE-OIL FEED

on the roof. These arresters are charged three times a day. A unique feature of the substation is that a private telephone system is installed for communicating directly with the load dispatcher in Portland.

The lighting load is handled by two 10-kw. 440—110-volt transformers in open delta in the basement, connected to 10 single-pole knife switches mounted on the lighting panel, each switch controlling one department in the plant.

Layout of Switchboard

The switchboard is divided into nine panels (Fig. 3). Natural black slate is used, and the oil switches are mounted on a framework and operated by bell cranks, with levers under the floor, leaving a clear passage behind the board. Single-pole unfused knife switches are mounted between the busbars and the oil switch on each panel, so that each department of the plant can be cut clear of the board without disturbing any of the remaining circuits. Current transformers on the two outside legs of each circuit are used for the indicating and integrating wattmeters on each panel. By means of these instruments a record is kept each day. The totaling panel has the following instruments mounted on it: An ammeter with a 3,000-amp. scale, an ammeter for measuring all three phases, an indicating wattmeter, a power-factor meter, a voltmeter, a Bristol recording voltmeter and two curve-drawing wattmeters—one belonging to the power company and the other to the cement company, one meter checking against the other. The power company also has an integrating wattmeter mounted on the back of the board.

Distribution of Power

The entire distribution system is underground. A main cable tunnel runs the entire length of the plant and is taken off to the various departments. All power and lighting cables pass directly from the switchboard into a cable tunnel that runs in the form of a T for 300 ft. The heavy power feeders, varying from 400,000 to 1,000,000 circ.mil, are carried on insulators, supported by galvanized-iron pipe frames built into the concrete walls of the tunnel, which is waterproof and is 5 ft. wide by 5 ft. high. All remaining power and lighting circuits are in conduit carried by the pipe frames, the entire system insuring absolute safety against interruption of service. All service taps are taken off in conduit, buried in the concrete, directly to the distributing compensator structure in each department.

Each department of the plant has all starting compensators assembled together on a structural-steel frame from which the various motor circuits radiate in conduit. Dustproof compensators were used throughout, having conduit entrance and outlet bushings. Each compensator is provided with an ammeter for all sizes above 75 hp.

The main circuit from the cable tunnel forms a busbar running horizontally above the system, from which taps are taken through three-pole knife switches in steel cabinets, whose functions are to disconnect each motor for repairs or when not in service.

A novel feature of the installation is that every motor has a 60-volt snap switch located directly at the motor and connected to the low-voltage release coil of the compensator by No. 14 duplex cable, so that the operator can open this circuit and shut down the motor, without taking time to go to the board, in case of emergency. This system of concentrated control permits one operator to stop or start some 700 hp. in motors without moving more than 10 ft., and in a very short time (Fig. 4).

H. P. Butchart, Victoria, B. C., is President of the company, and L. C. Newlands, Superintendent. The entire civil, electrical and mechanical construction was designed and supervised by the author.

The Lead-Drilling Beetle, described in "Engineering News" of Nov. 18, 1915, p. 1006, is still doing serious damage on telephone lines in California. In Pomona, Calif., on Sept. 30, when the first rain of the season fell, more than 50 lines of the local telephone company were put out of service by short-circuits in an hour. The beetle bores holes through the lead armor of the telephone cable; when rain comes, moisture enters the interior of the cable through the holes.

American Engineers Engaged in Developing Foreign Trade

The annual report of the American International Corporation, organized in New York City a year ago, is of especial interest to engineers because of the number of prominent engineers in its organization and because of the notable engineering enterprises which it has undertaken. The president, Charles A. Stone, is widely known from his connection with the firm of Stone & Webster, and on its Board of Directors are such prominent engineers as William L. Saunders, Guy E. Tripp, Edwin S. Webster and Henry S. Pritchett.

It was announced at the organization of the company that its principal purpose was to enlist American capital in the development of enterprises in foreign countries. Since the company was organized, Dec. 1, 1916, there have been 1,230 propositions submitted to the company for consideration.

These propositions were distributed among different parts of the world as follows: Africa, 29; Alaska, 4; Asia, 73; Australia, 10; Canada, 41; Central America, 47; Europe, 256; Mexico, 26; South America, 347; United States, 326; West Indies, 71. The propositions were classified as to their nature as follows: Agriculture, including irrigation, drainage, timber, sugar, cattle, etc., 143; commerce, 13; financing, 90; manufacturing, 201; merchandising, 139; mining, 185; public utilities, 127; railways, terminals, telephones, 332. Of the 1,230 propositions received, 917 were declined, and 313 have not yet been disposed of.

Among the enterprises which the company has actually undertaken are the contracts for building water-works and sewerage systems in the towns of Salto, Paysanbu, and Mercedes, Uruguay. This work was undertaken jointly with the firm of Messrs. Stone & Webster and the Ulen Contracting Co. It has been agreed to take $4,000,000 in 6% gold bonds of the Uruguay government in payment for this work, which is now well under way and will be completed during the coming year. There is other business of a similar nature pending both in Uruguay and in Argentine. Such enterprises can be undertaken advantageously whenever it is possible to sell such bonds in the United States.

To investigate propositions in South America, the Latin-American Corporation has been formed in conjunction with the firm of Stone & Webster to investigate construction propositions in South America and properly supervise the work during construction. The officers of this company are made up in part from the engineering force of Stone & Webster. An expedition to investigate opportunities in South America sailed from New York on July 29 last, and on its return to the United States it is expected that some undertakings will be entered into.

In the field of ocean transportation the American International Corporation has secured control of the Pacific Mail Steamship Co., and has acquired a large interest in the United Fruit Co., the International Mercantile Marine Co., and the New York Shipbuilding Co. It has also organized the American International Terminals Corporation to undertake the study of terminal problems at the port of New York and ultimately develop an organization for the construction of terminals, port works and harbor facilities in other places.

In connection with various contracts proposed in China, particularly for railway construction, the China Corporation and the Siems-Carey Railway and Canal Co. were organized in July last. Mr. Carey, of the Siems-Carey Co., of St. Paul, Minn., and a group of engineers and experts have been in China since August. The company has advanced to the government of China $500,000 to make surveys and other investigations for railways to be built under the contract. The work in China is in charge of Willard B. Straight, vice-president of the American International Corporation, formerly connected with the firm of J. P. Morgan.

The company is investigating various opportunities for business in Russia, and on Aug. 31, 1916, Frederick Holbrook, head of the Holbrook, Cabot & Rollins Corporation, was chosen vice-president of the American International Corporation to represent its interests in Petrograd. An office has been opened in Petrograd and a thorough investigation is now being made of two or three important matters with the aid of American experts.

Columbia University Organizes Engineering Society

In imitation of the association of the four national engineering societies (the United Engineering Society) the various student engineering societies of Columbia University have organized the United Engineering Societies of Columbia University. This is managed by a board similar to the Board of Trustees of the United Engineering Society.

The first meeting arranged under the auspices of the new society was a smoker on the evening of Dec. 14, at which Calvin W. Rice, secretary of the American Society of Mechanical Engineers; H. H. Norris, associate editor of the *Electrical World;* Charles Butters, mining engineer and metallurgist, and Herman A. Metz, former comptroller of the City of New York and a prominent manufacturer, were the guests and speakers of the evening.

Both Messrs. Butters and Metz talked chiefly in the strain of personal reminiscences; when a successful engineer or manufacturer tells intimately the steps and incidents which have led to fame and fortune, the talk is sure to be interesting, and judged by this meeting, highly instructive and inspiring to a body of engineering students.

Shutting Down Portland Cement Kilns on Sunday was the subject of a paper presented by G. F. Brown to the Portland Cement Association at its annual meeting on Dec. 12. The Alpha Portland Cement Co. began shutting down its cement kilns on Sunday in June last and has continued the practice ever since. After trying shutting down with the kilns empty and loaded, it has been found best to shut down the kilns with the load in them. It is found that the output per day for the days in operation has increased slightly over the output when the kilns are run for the whole week. While it is theoretically correct to say that it costs more to manufacture cement with the Sunday shutdown, the cost records do not as yet show any material increase. There does not appear to be the slightest change in the quality of output. The kiln linings do not last quite as long, but the cost of repairs appears to be lower. Though the wages per week are lower, since the wages paid are for six days' work instead of for seven, the workmen are satisfied with the change.

Erecting and Swinging 720-Ft. Span of Metropolis Bridge

Progressive methods were used in erecting the great channel span of the Metropolis Bridge over the Ohio River, on the new Paducah & Illinois R.R. of the Chicago, Burlington & Quincy. The span is 720 ft. long between centers of end pins. Though the trusses are 110 ft. high at midspan, they were erected by derrick car and crane, to which fact the speed of erection is largely due.

Swinging the span was done by lowering on hydraulic jacks and steel blocking, and was carried out in slow stages so that the elastic behavior of the silicon-steel structure could be studied. A remarkably effective, yet simple, rig was employed in the lowering.

The span is double-track, is semi-pinconnected, and is of subpost Pratt type, with 36-ft. subpanels. The subhangers are not connected to the chord, which eliminates an item of stress uncertainty. Stirrups formed on the ends of the subfloorbeams embrace and support the lower-chord bars. The eyebars are over 72 ft. long; their maximum size is 16x1 1/8 in., with 15-in. pins, both pins and bars being nickel steel. The rest of the span is "silicon steel," except that the rivets (1 and 7/8 in.) are carbon steel.

The erection machinery consisted of one derrick car, two 60-ton, one 85-ton, and one 150-ton crane; the latter was provided with three boom lengths; 85 ft., 110 ft., and 135 ft. The long boom set the high top chords; the heaviest of these weighed 44 tons and was set at 26-ft. reach.

Falsework bents were located under subpanel and main panel points, or at 36 ft. spacing, and rested each on a transverse row of piles driven in the sand bottom to 15 or 20 tons bearing power. On the piles were set three-story framed bents of 18 posts each; they were made of 12x12 yellow pine posts and 12x12 oak caps sized for depth with steel scabs bolted over all joints.

Piles were driven by a floating driver. The timber bents, however, were placed from the floor, working forward one subpanel at a time. The stringers were set on the bent as soon as this had been erected; then the track was laid on them and the derrick car moved forward to place the next floorbeam and still further forward to place the bent at the next panel point.

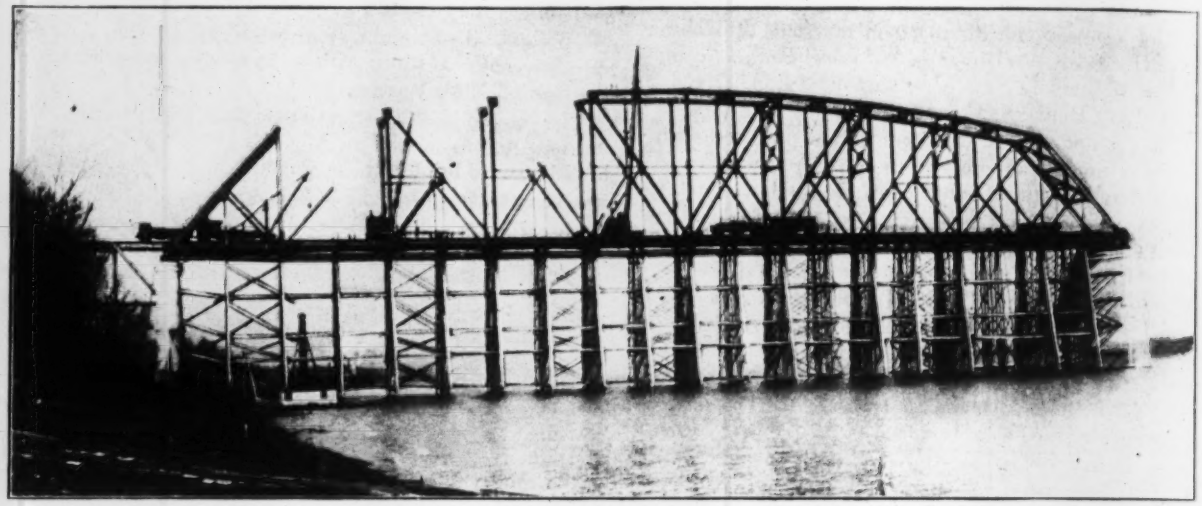


FIG. 1. ERECTION OF 720-FT. SPAN ON NOV. 25, 1916; CRANE WITH 135-FT. BOOM PLACING TOP CHORD

This work began Aug. 26, 1916, and was completed about the middle of October. It was followed by the laying down of the end sections of the bottom chord (four-rib stiff members for this 72 ft. length, the rest of the bottom chord being eyebars), and the erection of the end post bottom halves, the subhanger and the subpost. Then the vertical posts of the entire span were set up.

The posts were set on steel blocking built up of crossed layers of rails separated by plates and topped off by a pile of 1/2-in. shim plates totaling about 15 in. thickness. This blocking was for use in swinging the span.

Placing the eyebar lower chords through the posts gave some trouble, because of the great length of the eyebars—72 ft.—there being no chord connection at the subpanels (except at the middle of the stiff section, panel-point 1). In spite of block packing by which the eyebar groups were stiffened for handling, they proved excessively limber. The erectors would have preferred stiff members throughout, but the added weight was objectionable.

Erection of web diagonals and top chords started at the north (fixed) end of the span, and continued to panel-point 4 south, where it met erection work proceeding

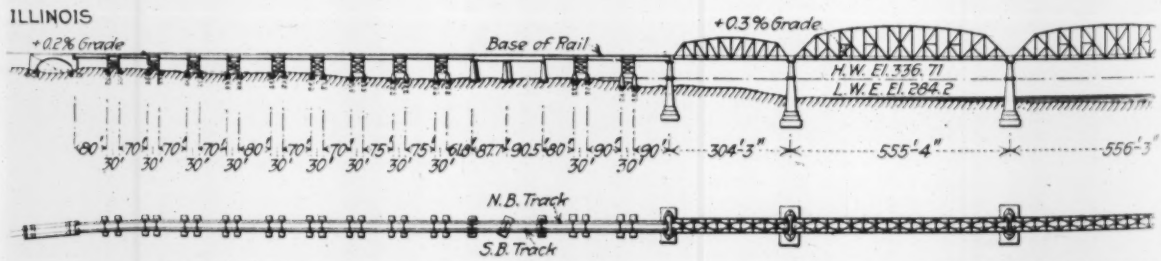


FIG. 2. OUTLINE ELEVATION AND PLAN OF THE METROPOLIS BRIDGE ACROSS THE MISSISSIPPI

from the south end. Closure was made Dec. 1, at pin 4.

The floorbeam blocking at the main panel-points had been removed when the posts were set, so as to bring the truss weight on a three-post group in the falsework bent, directly under the truss. The subpanel floorbeams, however, rested on their blocking until the span was connected up. This blocking was cut out when all was ready for lowering, on Dec. 7, and the whole load then rested on the steel blocking.

Practically no riveting had been done; only a few of the main web connections near midspan were riveted, and the other joints were merely drifted and bolted, practically full. The intention was to allow adjustment of all joints, and especially of all top-chord splices, while the span was being swung, so as to avoid introducing dead-load secondary stresses.

The most important region of secondary stress, the end triangle, was deformed during erection by depressing the middle of the end post about 2 in. and jacking up the middle joint of the stiff lower-chord section about ¾ in. The hip-vertical, consisting of two eyebars, was provided with a central plate web to partly stiffen it against buckling under the compressive load due to this distortion. A slight amount of transverse buckling was noticed in this member, however.

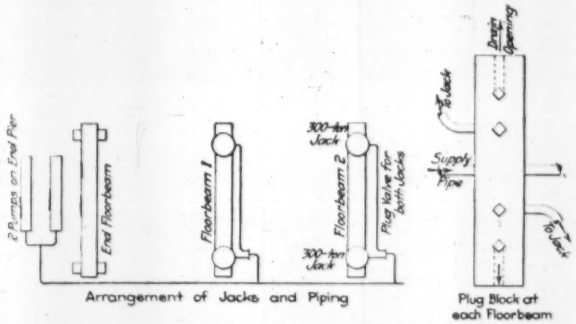


FIG. 3. JACK AND PIPING ARRANGEMENT

When the top chord was brought to closure, it came right within less than 1 in., and was easily drawn to bearing at the bottom flange. The top flange remained open about ¼ in., which could not close until the span was swung.

One 300-ton hydraulic jack was set under either end of each floorbeam, for swinging. All the jacks were coupled up to a single hydraulic line, in the arrangement shown by Fig. 3. The operation of lowering to swing consisted in jacking up one floorbeam, taking out a shim plate, lowering to bear, and then doing the same at the next floorbeam. In each stage, the work started at the fixed (north) end, as is customary practice.

The span had been built to a shop camber of 13 in., of which 8 in. represented dead-load camber plus pin clearance, and 5 in. represented camber for half live-load. The span is intended to be level under half live-load. About 3½ in. additional camber was put into the blocking, to allow for settlement and crushing down; some of this amount was left when lowering began. Exact elevations of the various panel-points for the true no-stress condition had been computed, and in the first stages of lowering the span was brought to this precise position. At this time also the longitudinal bracing of the falsework was loosened, to allow for the crawl of the truss during lowering. The span was then lowered carefully by ½-in. (and sometimes ¼-in.) amounts, and at the same time the temperature was read and the position of the expansion-end shoe was noted.

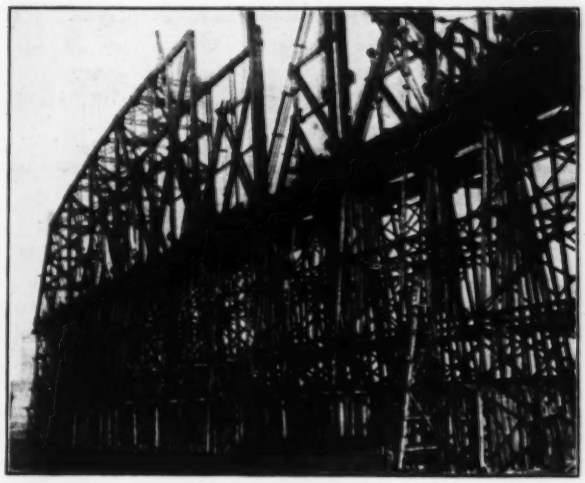


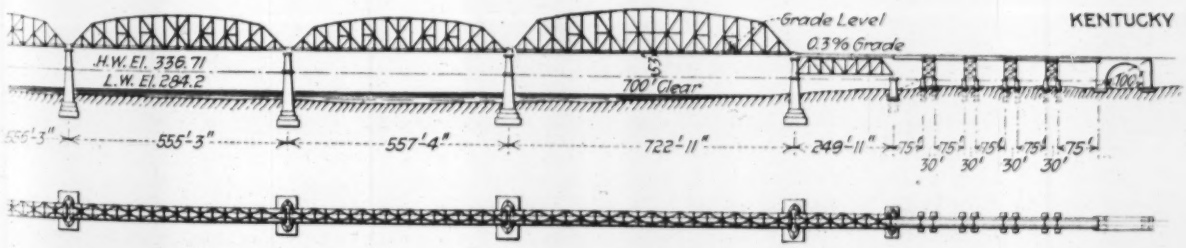
FIG. 4. SINGLE-BENT FALSEWORK OF 720-FT. SPAN

To lift one panel-point, usually three floorbeams were jacked; thus, points 4, 6 and 8 were jacked to lower point 6, and points 6, 8 and 10 were jacked to lower 8. The stiffness of the trusses and the desire to avoid excessive jack loads and local distortion were the reasons for this procedure.

Throughout the lowering, the span behaved as expected. It swung clear at 3 p.m., Dec. 11, and rough levels taken immediately thereafter indicated that the center is low (0.08 ft.) and the haunches high (0.02 ft.). The expansion shoes came within ⅜ in. of theoretical position, after temperature correction had been made.

The jacking process was exceptional in using remarkably high pressures. In some of the lifts a pressure of 11,000 lb. per sq.in. was indicated on the gage.

The work was carried out by the American Bridge Company, with H. A. Green in general charge and S. P. Franz in charge at the bridge. For the Paducah and Illinois Railroad, the work was directed by C. R. Fickes, Chief Engineer.



BETWEEN METROPOLIS, ILL., AND PADUCAH, KY., CHICAGO, BURLINGTON & QUINCY R.R.

News of the Engineering World

Power in National Forests

The annual report of H. S. Graves, Chief of the United States Forest Service, shows that 20 new power projects started operation during 1916 in the Government forest lands. This gave 18½% increase in the total number; about 42% of the total developed water power of the country utilizes national forests. In 1916, 40 applications for power-development permits were received—8 being from Alaska. California leads in amount of power under permit and in operation.

New York State Recovers Long Sault Rapids

A decision of the United States Supreme Court handed down last week declared unconstitutional the charter and rights given the Long Sault Development Co. by the New York Legislature in 1907. The charter granted rights for power development by construction of dams and locks; the bed of the stream was to pass to the company.

In 1913 the Court of Appeals held that the charter was for the control of navigation, divesting the state of which was beyond the power of the Legislature. It is estimated that 600,000 hp. can be developed on the American side of the Long Sault Rapids and 100,000 hp. on the Canadian side.

Civil Service Examinations Without Leaving Home

The Illinois State Civil Service Commission has adopted a new plan for holding examinations for Junior Highway Engineer, State Highway Department. This plan is to mail a list of questions to be answered by the applicants at their homes and returned to the Civil Service Commission. The questions will be designed to cover the training, experience and qualifications of the candidates. This plan was proposed by the engineers of the State Highway Department because the usual written technical examinations have not secured very satisfactory results. The examination for Junior Highway Engineer, announced for Feb. 3, 1917, will be open to non-residents of the state. The salary in $75 to $100 per month.

Illinois Central Terminal

Electrification of suburban traffic within five years is a prominent feature of the proposed new railway terminal and lake-front improvement proposition which the Illinois Central R.R. submitted to the City Council of Chicago, on Dec. 15. No steam locomotives would be run north of the 12th St. terminal, except those hauling freight trains to the yards along the Chicago River. The suburban line would have a loop beneath Grant Park, near the present Randolph St. suburban terminal.

The new main-line terminal station would be at the southeast corner of 12th St. and the extension of Indiana Ave. The railway would be depressed between 31st and 47th St. to enable the city to extend streets across the tracks to the new lake-front park. Another important feature is a proposed cross-town branch at 18th St. to afford connection with other lines further west and enable these lines to enter the new terminal station and abandon some of the present terminals. The lakefront park, to be formed by filling along the present shore line, would have a long lagoon, separated from the lake by an island parallel with the shore. The lagoon would have five public bathing beaches, and would be crossed by a number of bridges. To meet the demands for an outer harbor, the stretch of new lake-front from 12th to 31st St. is designated as a harbor district. The ordinance must be approved by the City Council and the South Park Commission before it can go into effect. The cost of the work is estimated at $20,000,000 to $25,000,000.

Los Angeles Power-Line Suits Are Ended

The City of Los Angeles, the Pacific Light and Power Co. and the Southern California Edison Co. have finally come to an agreement on the city's taking over the lines of these companies inside the city, for the distribution of power from the generating plants of the municipal aqueduct. This adjustment ends a long dispute over the value of the lines and the severance damages that would be caused by expropriation, and makes unnecessary the duplication of lines. The agreed price is $9,415,000—made up of $8,270,000 for the physical property and $1,145,000 for severance damages. These sums are based on the findings of the State Railroad Commission in the eminent-domain proceedings brought before it. The city agrees also to purchase from the two concerns such power as it needs while its generating system is being built up, the price being cost plus severance damages. The city is now selling power at 5c. per kw.-hr. base rate.

As a sequel to this agreement, it is announced that the Pacific Light and Power Co. and the Southern California Edison Co. will consolidate and retire from business within the city. The new concern will be known as the Southern California Edison Co. and will be in size about the fifth power company in the country. It will have five steam and thirteen hydro-electric plants of 130,000 and 150,000 hp. aggregate capacities. There are owned undeveloped water powers aggregating 4,000,000 hp. The new concern will have 1,380 mi. of transmission lines, 103 substations and 3,700 mi. of distribution lines reaching some 165,000 customers in 150 towns and cities.

The Edison company will take up 95% of the capital stock of the Pacific company and assume its bonded debt of $25,000,000. The face of Pacific stocks, bonds and

notes taken over is $31,880,298, and for it the Edison company will issue $12,029,900 of 5% second preferred stock, give $4,000,000 cash and issue $11,152,200 in common stock to remain in the Pacific treasury.

At this same time the city's condemnation suit for a 150-ft. right-of-way in the San Fernando Valley was finished in a local court. The six large real-estate holders were allowed $46,545, which was more than the city appraisal ($15,282), but much less than the owners' figure ($337,250).

Progress on the Minneapolis Concrete-Arch Bridge

The work on the Third Ave. reinforced-concrete arch bridge across the Mississippi River at Minneapolis, Minn., has not made such progress during 1916 as had been expected. A late start was made, and as the work now being done consists of the floor slabs and intermediate bents, it was necessary to stop as soon as freezing weather began, so as not to take any chances of injury to the concrete. The accompanying view (looking eastward) shows the condition of the structure two weeks before construction was shut down. In the distance will be seen one of the towers of the double cableway employed in handling material all the way across the bridge.

LOOKING ACROSS THE THIRD AVE. BRIDGE AT MINNEAPOLIS

The bridge (described at some length in *Engineering News*, Dec. 30, 1915) is peculiar in having a reverse curve in plan, the location being so made as to place all the piers on solid rock and to avoid breaks, or faults, in the rock of the river bed. The bridge is 2,223 ft. long, with five arch spans of 211 ft. and two of 134 ft. The structure was designed by F. W. Cappelen, City Engineer of Minneapolis, and is being built under his direction by city forces on the day-labor system.

Chicago Engineers Ask for Higher Salaries

The high cost of living has led the engineering employees of the City of Chicago to submit to the Mayor and City Council a petition requesting a substantial increase of salaries. The present rates of pay were established in 1910, but are not materially different from those prevailing since 1897. The changes suggested for the three principal grades are as follows:

	Present Pay	Proposed Pay
Grade 1	$90 to 110	$120 to 140
Grade 2	125 to 145	155 to 185
Grade 3	160 to 200	200 to 240

The petition is accompanied by diagrams and tables showing the rise in cost of food, and comparing the rates of payment for common and skilled labor, foremen and engineers. The following is a quotation from the engineers' petition:

> We submit that when engineers, who are in charge of work and responsible for its proper execution, are paid less than the foremen and some of the mechanics working under their direction and supervision, neither will attain the highest efficiency; the engineer, because he is discouraged by the comparison; and the workman, because he feels that the man over him is not recognized by the authorities. We now request that our salaries be also increased in order to maintain the proper relation between the compensation of laborers, skilled mechanics and technically trained men.
>
> On the men in the engineering service of Chicago rests the responsibility to design and execute the municipal improvements of the city, costing millions of dollars. A corps of men feeling themselves underpaid as compared with other employees cannot, in spite of the best intentions on their part, render the service which will result in the most economical expenditure of the city's funds appropriated for such improvements.

Profit-Sharing Franchise Asked in Minneapolis

The Minneapolis Street Railway Co. has submitted to the City Council a draft of a desired franchise that has been framed as the result of various conferences over the local traction situation.

The company asks for: A 30-year franchise containing customary provisions, with an additional 30-year term if council does not see fit to buy; 7% on the investment; half the surplus earnings until 1923 and then one-fourth; a general protective clause to prevent the city from requiring the company to do anything, beyond giving good service, that will impair the capital value of the company.

The company offers: To surrender its present franchise right, Jan. 1, 1918; city always to have right to purchase on one year's notice; company to initiate $1,000,000-a-year set program of extensions, new lines and general improvements, to be agreed on and specified in franchise; council thereafter to have full power to enforce extensions and new lines; council to have right to regulate service and construction; city to have 50% of

surplus earnings until 1923 and then 75% ; city to have privilege of applying surplus toward reduction from the prescribed 5% ; universal transfer, but not to permit "looping"; city council to employ street-railway supervisor and staff and to require company to bear expense thereof; company to make financial reports to city and to permit inspection of books; company to pave and repair its right-of-way, to sweep, oil and sprinkle it; width to be 19 ft. in place of 15 now in force; company to grant suburban lines right of use of tracks into city center.

A recent valuation of the company's property by the City Engineer, F. W. Cappelen, showed $21,152,221 present value of physical equipment, $4,270,230 business development, $631,857 power-plant leases, $1,300,000 terminal block, $142,045 property outside of the city; total, $27,496,353.

Changing Highway Officials for Politics Expensive

The American Highway Officials Association, which met in St. Louis, Mo., the week of Dec. 4, adopted the following resolution:

We deplore the changing of local and state highway officials for political reasons and suggest that the energies and efforts of this Association be exerted to establish in the public mind and conscience a recognition and appreciation of experienced and faithful officials. The public must pay the expense of training every person engaged in administrative and scientific pursuits that affect the public interest, and as sound business officials who have been trained, or who have acquired experience, they should be retained in office so long as they render service with a loyalty of purpose. The keynote that should govern the selection of highway engineers should be efficiency. For this reason we would urge upon the legislatures and governors of every state to secure the passage of such laws as will place the office of highway engineers free from political embarrassment and secure to the people the benefit of experience for which they have paid. Until this method is established and the public realizes the importance of such a move, the taxpayers of the country cannot hope to receive the best results for their money.

Other resolutions passed at the meeting recommended the passage of the bill now before Congress, which provides for the working of Federal prisoners upon the public roads; pledging the coöperation of the state highway officials and departments in carrying out the Federal aid road law; and recommending a conference of representatives from the various state highway department laboratories to obtain closer coöperation with the testing laboratories of the Federal Government. The Federal Trade Bureau was asked to investigate alleged illegal practices on the part of owners of patents on road-making processes and methods. It was recommended that the various good roads organizations endeavor to consolidate, or at least arrange for a single national meeting.

Five Second Lieutenants of Engineers in the United States Army were appointed from civil life as a result of the recent examinations. This brings the civilian appointees to the Corps of Engineers up to thirteen.

Cleveland Garbage Tankage will yield the city $57,600 in 1917 for an output of 6,000 tons, in accordance with a contract just let to F. G. Royster, Norfolk, Va. This is said to be the highest unit price ever received.

Paving and Street Repair Work in New Orleans, La., next year (1917) will amount to $750,000, according to present estimates. Newspaper reports state that the larger part of the new pavements will be of creosoted wood block.

St. Louis County Road Bond Issue Is Valid, according to a decision of the United States District Court. This will make $3,000,000 available for road improvement around St. Louis, Mo., unless further legal obstacles are encountered.

Improvements to the Water-Works of Atlanta, Ga., recommended by Z. Smith, manager, include: Low intake dam across Chattahooche River, $15,000; coagulating basins, $150,000; clear-water reservoir, $100,000; 20,000,000-gal. pump with boilers, etc., at Chattahooche River station and also at Hemphill station, $400,000 for the two; cast-iron pipe in place, $310,000.

Sewage Disposal for Buffalo, the Tonawanda's, La Salle and Niagara Falls, N. Y., is being investigated by Rudolph Hering and George W. Fuller, New York City, and Harrison P. Eddy, Boston, to pass upon questions raised by the International Joint Commission in its studies and recent report on the pollution of the boundary waters of the United States and Canada.

The Memphis Municipal Electric Project has been dropped by the city government. An agreement has been made with the two local companies for 33⅓% reduction in rates and the payment of $100,000 by the companies. The new base rate is 6c. per kw.-hr. and the minimum is 3c. A 30c. service charge is allowed, but no charge is to exceed 7½c. per kw.-hr. The two concerns will consolidate under an extended franchise. The city will cancel the $1,500,000 bonds already sold and pay the purchasers $15,000.

Reservation of Petroleum Deposits on Government lands for naval use was recommended by the Naval Consulting Board on Dec. 9. In view of the adoption of oil fuel for naval vessels the board believes the Government should reserve the title to public lands containing oil deposits sufficient to assure the supply of the navy for at least half a century to come. The navy is now using 842,000 bbl. of fuel oil a year in time of peace, and it is estimated that this will increase to over 10,000,000 bbl. in 1927. In time of war this consumption would be increased at least threefold.

That the Activated-Sludge Process will handle the trade wastes from the Chicago packing-house district in such a manner as to produce an effluent suitable for discharge into the channels of the Sanitary District of Chicago, is the conclusion of a report made to the Sanitary District. This report was prepared by Langdon Pearse, division engineer, representing the Sanitary District, and Dr. W. D. Richardson, chief chemist, Swift & Co., representing the stockyards interests. Having decided upon this point they are now considering the manner of collecting the sewage and wastes from the several plants, and also the general character of the works necessary for carrying out this treatment.

An Increase in Car Demurrage Rates went into effect on Dec. 15 with the approval of the Interstate Commerce Commission. The receiver of a carload of freight has two days' free time in which to unload his consignment, after which demurrage will be charged at the rate of $1 for the first day, $2 for the second, $3 for the third, $4 for the fourth and $5 for the fifth and each succeeding day that the car is detained. At the same time the railways raised the per diem rate for cars used in interchange from 45c. a day to 75c. a day. It is hoped that this will have some influence in impelling railway companies to send home cars belonging to other companies which they are now detaining for their own use.

Water-Works Improvements at Nashville, Tenn., have been reported on by a committee of the Nashville Engineering Society, headed by W. H. Schuerman, dean of engineering, Vanderbilt University. The committee advises that instead of carrying out immediately the $1,750,000 scheme of Commissioner Robert Elliott, now before the City Commission, less extensive improvements at a cost of about $500,000 be made to serve for some years. The Elliott scheme included a new intake and pumping station with two low-lift and two high-lift pumps 5 mi. in a straight line and 12 mi. by river above the present intake and above two undesirable tributaries of the Cumberland River; a 75,000,000-gal. coagulation and sedimentation basin at or near the new pumping station; two 36-in. force mains, 62,280 ft. long, and the use of the present settling reservoir as a clear-water basin. The committee already named says the Elliott project is feasible, but thinks its execution should be deferred. The committee advises the employment of an outside engineer to pass on the alternative plans for improving the present pumping station, as proposed in 1915 by Barclay Parsons & Klapp, consulting engineers, New York City. (See "Engineering News," Dec. 16, 1915, p. 1196). One of these plans was for a 20,000,000-gal. steam pumping engine and the other was for three electrically driven 7,500,000-gal. centrifugal pumps. The committee recommends the employment of a bacteriologist to make daily tests of the water; a chemist for occasional tests; a draftsman to prepare maps of the distribution system and to do other work; and that the reserve coal supply be increased to a month from the present supply of only a few days.

PERSONALS

W. J. Parkes has been appointed County Highway Engineer of Jefferson County, Arkansas, succeeding H. H. Humphreys.

E. L. Crugar, Assistant Engineer of the Illinois Central R.R., Chicago, Ill., has been promoted to be District Engineer at New Orleans, La.

E. L. Cannon, recently chief clerk to the Chief Engineer of the Seaboard Air Line Ry., has been promoted to be Office Engineer at Norfolk, Va.

J. Harry Denne, Assistant Engineer in the city engineering department of Indianapolis, Ind., has resigned after about 25 years' continuous service.

W. S. Curtis, of San Francisco, has been appointed Assistant State Engineer of California. He was one of three who passed the required civil service examination.

J. H. Schuch has been appointed Chief Engineer of the Butte, Anaconda & Pacific Ry., to succeed Charles A. Lemmon, resigned, as noted in these columns, Nov. 9, 1916.

W. L. Kellogg, Superintendent of Motive Power of the Missouri, Kansas & Texas Ry., has resigned to accept the same position with the Chicago, Rock Island & Pacific Ry.

C. C. Huffine has been appointed City Engineer of Frankfort, Ind., succeeding the late R. H. Boynton. He served as City Engineer previous to 1905, when he entered the contracting business.

Robert E. Barrett, Assoc. M. Am. Soc. C. E., formerly Acting Chief Engineer of the Directors of the Port of Boston, Mass., is now with Fay, Spofford & Thorndike, Consulting Engineers, Boston.

W. D. Salter, for the past 10 years an Assistant Engineer in the city engineering department of Denver, Colo., has been appointed City Engineer of Boulder, Colo., succeeding George R. Joslin, resigned.

John Swan, Jr., has been appointed Director of the Department of Public Works of Pittsburgh, Penn., succeeding the late Edward M. Bigelow. He is a brother of the late Robert Swan, the former Director of Public Works.

Gordon Sumner, Civil Engineer, of Wauchula, Fla., has been appointed Highway Engineer of Bay County, Florida, of which Panama City is the county seat. He will have charge of surveys and construction of a road system to cost $375,000.

W. F. Angus, M. Can. Soc. C. E., Vice-President and Managing Director of the Canadian Steel Foundries Co., Montreal, Que., has resigned to become an official of the Dominion Bridge Co., Montreal, with which he was formerly connected.

Theron Wasson, formerly connected with the New Jersey and Pennsylvania joint commission on toll bridges over the Delaware River, has been appointed Water Engineer of the Department of Conservation and Development of the State of New Jersey

C. E. Scribner, F. Am. Inst. E. E., Chief Engineer of the Western Electric Co., New York City, has been relieved of his executive duties, at his own request, and has been appointed Consulting Engineer of the company. He has been connected with the company for 40 years.

W. L. Clark, Assistant Highway Engineer, State Highway Department of California, has been made Division Engineer of the division including San Francisco, to succeed A. E. Loder, who resigned to become Assistant Chief Engineer of the United States Office of Public Lands, as noted in these columns, Oct. 26, 1916.

John P. Morgan, a student in the School of Applied Design, Carnegie Institute of Technology, is the winner of the $250 prize offered by the Pittsburgh Beaux Arts salon for designs of methods of improving street intersections in the residential districts of the city. The competition was open to all engineers, architects and students in Allegheny County.

George McCormick, former Mechanical Engineer of the Southern Pacific Ry. and more recently Assistant General Manager at Houston, Tex., has been appointed General Superintendent of Motive Power of the lines west of El Paso, with headquarters at San Francisco, Calif. He is a mechanical engineering graduate of the Agricultural and Mechanical College of Texas, class of 1891, and entered the railway service as a shop apprentice of the Galveston, Harrisburg & San Antonio R.R.

OBITUARY

Frederic H. Reed, Assoc. Am. Inst. E. E., Vice-President of J. G. White & Co. and a director of many electric companies, died Dec. 9 at his home in New York City.

Erwin Chester Sherman, Mechanical Engineer with the William B. Pollock Co., Youngstown, Ohio, died Dec. 8, aged 36 years.

Grant Rohrer, M. Am. Soc. C. E., a contractor of New York City, died Dec. 12. He was born in Lancaster, Penn., in 1864, and his early experience in engineering was in Western railway construction. He opened a New York office as a contractor in 1890.

William C. Nixon, President of the St. Louis & San Francisco R.R., died Dec. 16, in his 59th year. He was born in Illinois and began his railway experience as a bridge carpenter on the Burlington & Missouri R.R. in Nebraska in 1878. From this position he rose through clerical work to become Trainmaster of the Southern Kansas Ry. in 1885. In 1900 he became General Superintendent of the Gulf, Colorado & Santa Fe Ry., at Galveston, Tex., and in 1906 General Manager of the St. Louis & San Francisco R.R. He was elected President in 1913.

F. C. Fisher, President of the Ferro Construction Co., Chicago, whose death on Dec. 6 was noted in these columns last week, was born at Lake Linden, Mich., May 24, 1871. He graduated from the grammar and high school at Lake Linden, and also graduated from the Engineering Department of the University of Michigan at Ann Arbor. After leaving the University he was employed by the Detroit Bridge Co., and also the American Bridge Works, of Chicago, as draftsman and engineer. In 1899 he had charge of the erection of the steelwork for the Great Northern Ry. grain elevator at West Superior, Wis. He also had charge of the erection of the railway cantilever bridge over the Mississippi River at Thebes, Ill., and the bridge of the Fort Dodge, Des Moines & Southern Ry. at Fort Dodge, Iowa. In March, 1907, he and B. B. Sierts formed the Ferro Construction Co., of Chicago, and he was its President until his death. His company has done erection work for several of the large railways, and its business will be continued. His most recent work was the erection of the 600-ft. steel-arch span for the new Detroit-Superior viaduct at Cleveland, Ohio, and he also erected the mile of steel towers and girders for the new Clark Ave. viaduct, at Cleveland. Mr. Fisher leaves a widow and two children.

ENGINEERING SOCIETIES

OKLAHOMA SOCIETY OF ENGINEERS.
Dec. 27-28. Annual meeting in Tulsa. Secy., H. G. Hinckley, Oklahoma City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at Chicago. Secy., D. K. Shedd, Ames, Iowa.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION.
Jan. 15. Fourth annual meeting in New York City. Secy., O. S. King, 120 Broadway, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at Society House, New York City. Secy., Charles Warren Hunt, New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

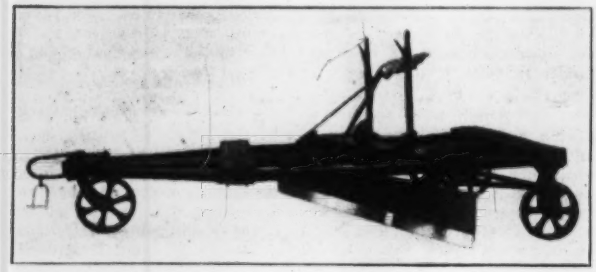
SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 19th St., Kansas City.

The Minnesota Branch of the American Water-Works Association was organized at a recent meeting in Minneapolis. The officers elected are: President, F. W. Cappelen, city engineer of Minneapolis; vice-president G. O. House; treasurer, W. R. Young; directors, William Todd, L. A. Gordon and D. A. Reed. The meeting was attended by about 30 water-works men, of whom two-thirds were members of the American Water-Works Association.

Appliances and Materials

Light, Inexpensive Road Plane

A road plane, of light and simple construction and with an adjustable cutting blade has been put on the market by the Hodge Road Machine Co., Ligonier, Ind. The cutting blade is so arranged that it can be lifted clear of the ground or, by the use of levers, can be made to cut to a depth of several inches,



NEW $50 ROAD PLANE

either horizontally or at an inclination, so as to give a finished crown. The accompanying illustration shows its size and appearance. It is sold for $50.

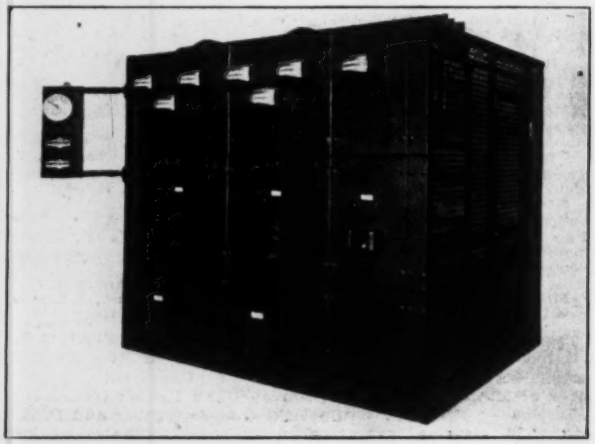
* * *

Safety-First Switchboard

In response to the demands of large users of electrical machinery the General Electric Co., of Schenectady, has developed a type of switchboard, shown in the accompanying view, on which it is almost impossible for an attendant to be injured.

All live parts, except current and potential receptacles, are inaccessible from the front of the board, and the live parts of these receptacles are recessed so that accidental contact with them is difficult. Grillework screens afford protection against accidental contact with live parts in the rear of the board. Hinged doors provided with spring locks are placed one on each side of the grillework, making it impossible for anyone other than an authorized person holding the key to enter the space at the rear of the switchboard.

Disconnecting switches are used between all oil circuit-breakers and busbars, and provide convenient and rapid isolation, without hazard of the breakers from the bus for inspection, changing oil or repairs. Instead of the usual calibrating switches back of the panel this board is equipped with front-of-board calibrating receptacles that permit safe and convenient calibration of instruments and meters from the front. The board is also equipped with removable fuse receptacles of the screw-plug type, which provide for a replacement of secondary-potential transformer fuses from the front of the switchboard without the danger of contact with live parts. The live parts of the field switches are mounted on slate bases back of the panel and are connected to operating handles on the front of the board by rods and bell cranks. With this mounting, it is impossible for the switchboard attendant or the instruments to be injured by the arc as sometimes happens with the live-front type. When switches are required for arc or incandescent circuits, they are of the dead-front style.



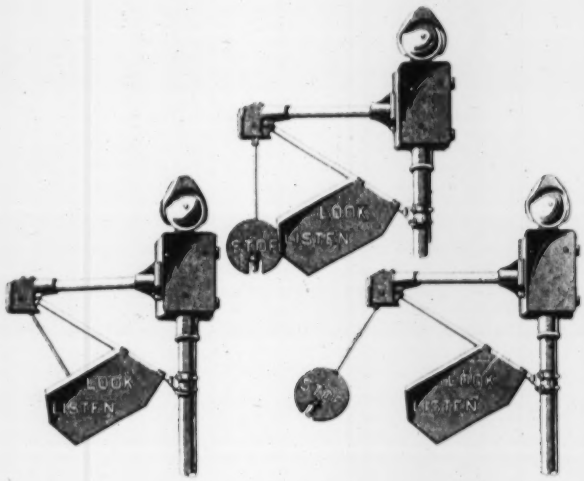
DEAD-FRONT SAFETY SWITCHBOARD

* * *

Closed-Circuit Automatic Flagman

The growing demand for visual warning signals (commonly called "automatic flagmen") for railroad grade crossings has led the Union Switch and Signal Co., of Swissvale, Penn., to develop a type that embodies many of the safety principles of automatic block railway signals—notably, reliance on a closed electric circuit to hold the signal at clear, so that in any trouble the caution warning is exhibited.

Under normal conditions this flagman indicates the approach of a train by swinging a red banner on which appears the word "Stop" and displaying a red light attached



LOCKED, WORKING AND DEAD POSITIONS OF UNION GRADE-CROSSING SIGNAL

to the banner. When no train is approaching, the banner is held to one side between two screens, upon which is painted "Look and Listen," and the lamp suspended from the banner is not lighted. If the circuit through the holding magnets is broken, but the apparatus is otherwise in good condition, the banner will swing irrespective of the approach of a train. If the circuit is broken through the operating magnet, but not through the holding magnet, the banner will be retained in its extreme position between the screens until a train approaches, when it will be released and ultimately assume a vertical position with the banner stationary, but fully displayed. If current is totally cut off the mechanism or if the operating parts become disconnected, the banner will also assume the vertical position and be fully displayed.

The operating mechanism is inclosed in a weatherproof case and consists essentially of an operating magnetic mechanism for driving the swinging banner, and of holding magnets for retaining the banner at one end of its arc of travel. This flagman is designed to operate normally at 10 volts, direct current. It requires an average of 0.4 amp. for swinging the banner, and 0.4 amp. for the 5-watt 12-volt banner lamp, making an average of 0.8 amp. drawn from the battery while the banner is swinging. The holding magnets require normally only 0.01 amp. when the flagman is latched in the clear position. The control of this flagman is so arranged that it is unnecessary to break the operating circuit through relay contacts. The only current passing through these contacts is that required for holding the mechanism in its latched position.

The flagman can be equipped with a bell and with either an oscillating or a fixed lamp. If desired, the fixed lamp can be arranged to burn oil and to give alternately red and white flashes of light as the banner swings to and fro, and a white light when the banner is latched clear. The control of the flagman can be effected by any of the well-known automatic or nonautomatic methods in general use, and the flagman itself adapted to any ordinary condition of highway protection.